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LEY-FARMING AND A LONG-TERM AGRICULTURAL POLICY*

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MY own leaning is towards the word 'ley,' although according to the Oxford Dictionary this word is obsolete, but in adopting ley I follow the best agricultural precedent.

It is not my intention to talk about farming for laymen, for in my opinion ley-farming properly understood is the most highly scientific farming that it is possible to practise. The ley farmer must be a proficient stock-master and a proficient cultivator, versed alike in the arts of animal and crop husbandry. 'To be a farmer' is 'to till the soil,' and in 'till' is implied the bringing of the soil into a fit condition for the production of crops—the care of the soil. A farmer in the true and proper meaning of the word is a man who has ever before him two purposes: the one to put all his fields to optimum use in respect of commodity production, and the other, and of even greater ultimate importance, to attend to the maximum need of all his fields in respect of soil fertility. Thus judged, my thesis is that the ley farmer is a farmer *in excelsis*.

My address has to do with the most honourable, and what should be the most venerated, aspect of the whole of agriculture—the rotation, for upon the rotation I claim everything depends. So I at least respond to the honour that has been done me in placing me in the position in which I find myself to-day in the selection of my subject. It is a neglected subject. I am the first President of Section M to do homage to the rotation. I have researched amongst the utterances of my distinguished predecessors; incidentally, although of interest only to myself, I find that the first Presidential Address to Section M was given by Sir Thomas Middleton in the year that I came into Wales and began my researches on grassland—that was in 1912. The only mention of the rotation in the total of twenty-four addresses that have been given was by Sir John Russell, who in 1916 started off promisingly with winter cereal: spring cereal: fallow, but to my intense disappointment followed the rotation no further.

In view of the immense amount that has been published during the present century it is not without significance that the leading agricultural journals contain but few articles dealing primarily, or even remotely with the rotation, and next to

*Presidential address delivered to Section M (Agriculture) of the British Association for the Advancement of Science, at Cambridge, August, 1938.

nothing relative to the basal philosophy of the rotation. The truth is that agricultural thought in recent decades has turned ever more exclusively towards the narrow, too narrow as I think, path of commodities, each considered as such. Excessive concentration on commodities leads inevitably towards monoculture, and to what we too lightly please to call specialization, and leads away from the rotation and ultimately to disaster. Greatly daring, then, I have set myself to combat this modern fetish of over-concentration on commodities, a fetish that has revealed itself not only in the trends of agricultural science, but in a very great deal of what the State has endeavoured to achieve for agriculture and which daily reveals itself in the actions and utterances of the leaders of the agricultural industry.

I think that everybody will be agreed that such is the precarious state of the world to-day, and of this country in particular, that there can be only one approach to the problems of agriculture, and that is the national approach. We must not so much consider what is good for the farmer as what is good for the State: then what is good for the State must be made good for the farmer. That is the only possible approach towards a stable and long-term agricultural policy. A long-term agricultural policy, if it is to be enduring and adequate, must envisage both present and future needs of the State. The success of the policy must be judged in the main by one overriding consideration, namely, the sureness and rapidity with which the farmers of the country (all the farmers of the country) in order to meet any emergency prove themselves able either to pass from the production of one series of commodities to the production of another, or, radically to alter the proportions of the several commodities produced.

It so happens, at least it appears to me, that the present needs of the State, and also the more menacing of the foreseeable contingencies, unite to demand one and the same essential contribution from our agriculture. It is not for me to attempt to decide whether war danger, or the danger of our about-rapidly-to-dwindle population is the greater peril; little less disconcerting are the effects of soil erosion and soil depletion in those countries from which we are wont to obtain abundant and cheap supplies of food. I am concerned with a long-term agricultural policy, the kind of policy that would take at least ten years to put into full operation, and consequently we have to consider not so much immediate war danger as war danger as such, a danger that owing to our island position would seem to be something from which it is now hard to see how we shall ever escape. I believe the extent of the influences of soil erosion and depletion is not even yet fully realized. All methods of countering this must in the last resort react against the British housewife, and must tend to increase the cost of overseas production, while taking soil erosion, soil depletion and land deterioration together a vaster area of the globe is undoubtedly affected than is generally supposed.

Our own rough and hill grazings have manifestly deteriorated: witness the spread of bracken, to quote only the most obvious but by no means the most serious example. They have become increasingly depleted of lime and phosphates in recent decades, and the same thing must be happening to a greater or lesser extent—and sometimes accompanied by actual erosion—in all the great ranching areas of the

world. In framing our own long-term agricultural policy heed must be taken of every shred of evidence on land deterioration that is available all the world over, for it is patent that when the sum is totted up the total will far exceed what is already only glaringly manifest.

The immediate, and on all hands generally admitted, need of our peoples is an abundance of fresh food. An abundance of fresh food is not compatible with a superabundance of permanent grass. Since permanent grass flows like the sea right up to the very doors of some of our largest centres of population, such centres of population are automatically denied an abundance of really fresh vegetables.

I make no apology for this somewhat long, and in a sense non-agricultural and at all events non-technical introduction, for it seems to me imperative to stress our national needs, for it is these needs which should govern our whole agricultural outlook and, therefore, should determine all our systems of farming. To sum up so far, and on the strength of the various considerations I have brought forward, I would say this. What is demanded of our agriculture is, *firstly*, to maintain as large a rural population as possible, for probably on a large and contented rural population depends to a marked degree the increase of our population as a whole. *Secondly*, to maintain as large an acreage as possible in a highly fertile and always ploughable condition, and *thirdly*, so to conduct our farming as to allow at all times, and in all places, for the absolute maximum of flexibility in commodity production.

Before further developing my argument I must endeavour to put ley-farming in its proper perspective in relation to other systems of farming. I must therefore, and as a further preliminary, attempt to define the systems of farming as conducted in this country.

My concern is to define the systems not in terms of commodity production, but in terms (*a*) of their flexibility, (*b*) of their indebtedness to imported feeding stuffs, (*c*) of their relation to the maximum needs of the soil in the matters of maintenance and enhancement of soil fertility, and (*d*) as to the amount of labour demanded. For if my major premises are anything approaching to correct, these are the matters of supreme national importance. My classification is, of course, amenable alike to amplification and simplification, and I put it forward to-day quite tentatively and primarily to illustrate the principles which I consider absolutely basic to any rational consideration of a long-term agricultural policy for this country. Here is my classification.[1]

Arable Farming.—A small acreage of permanent grass—a few odd corners, a couple of fields—may be conceded to even the arable farmer. For the rest he must be presumed to take the plough around his whole farm, and

(*a*) work on a rotation of crops without any resort to the ley,[2] or

[1] I first put forward this classification in *The Fortnightly*. (**9**)

[2] A ley is a field sown down to grass and/or clovers, and is such that it is designed to take a definite place in the rotation of crops. Leys are of two main types ; the one-year, or 'arable' ley, and the ley of two or more years' duration. Implicit in the idea of the ley is, however, the conception of 'due date' : after an appropriate, and within fairly narrow limitations, pre-defined, period it becomes due to be ploughed up.

(*b*) adopt a rotation which involves the use of the one-year ley only.

The arable farmer as thus defined is never a grazier. When the one-year ley is employed this is for the primary purpose of producing hay for horses or stall-fed animals, and contributing to the muck heap, while the clover sod as such contributes to the fertility of the farm. The major function of the ley is here the maintenance of soil fertility. The chief concern of the arable farmer is the production of cash crops. His system is capable of extreme flexibility within the sphere of crop husbandry, it is capable of employing much labour—market gardening, and relatively little labour—mechanized wheat growing. It is a system which from the point of view of soil fertility is easily abused, and which in some of its forms, *e.g.* market gardening, makes excessive claims on farm and stable manure (when obtainable) from sources outside the boundaries of the farm. The robbing of 'Peter' ('Peter' in this case being the hay and straw producing fields of other, and often remote, farms) to pay 'Paul' (the truck crop fields) is an aspect of large-scale market gardening which has from the national point of view, I think, never been fully appreciated.[3]

It is likely that the market gardener in his own interest will be driven increasingly to adopt a system of alternate husbandry as presently to be defined—town stable manure being a rapidly waning commodity.

Alternate Husbandry, or, as I prefer to call this system, *Ley-Farming*.—A couple or so fields of permanent grass can be conceded to the ley as to the arable farmer, but for the rest the ley-farmer takes the plough in ordered sequence around the whole farm. Ley-farming is of two main types, but always the majority of the leys employed will be of two or more years' duration, and always in any particular year the area of the farm in leys (and therefore in grass) will be not less than one-third of the ploughable acreage; will frequently be over three-quarters of that acreage, and in extreme cases, and at unusual periods, the whole of the farm may be in leys. The main points to be emphasized are these. The ley-farmer is of necessity, and essentially, a grazier and a crop husbandryman; he may also be a feeder. He must, therefore, be equipped for crop and animal husbandry, and, as I have already said, to be successful he must be proficient in both arts of farming. His system, his mental stock-in-trade, and his equipment on the farm all bear the same hall-mark, and the hall-mark above all others of value to the nation, to wit, FLEXIBILITY.

The ley to the ley-farmer has two equally important functions to perform: the sward, or animal ration function, and the sod, or soil fertility function; of this duality, which to my mind is at the root of successful farming in all the moderate to high rainfall areas of the temperate regions of the world, I shall in a moment have much more to say.

The two main types of ley-farming I will define as follows:

The Arable-Grass Rotation.—In the arable-grass rotation most usually the leys are of two or three years' duration. The area in grass at any time will not exceed

[3] A good many acres near London once devoted almost entirely to the production of hay for the City horse, and therefore also of manure for the market gardener, still show the mal-influence of that type of monoculture.

50 per cent of the farm, and may be somewhat less. Good examples of this system are the arable dairy farming of Denmark, and the rotations practised in Aberdeenshire in connexion with beef production. In both cases animal products are the chief concern of the farmers, and the holdings produce at least a good proportion of the winter rations. The mechanized cereal grower may also adopt the arable-grass rotation, primarily with a view to maintaining soil fertility and to making it easier to get on his land during periods of sketchy weather. A typical rotation would be wheat : grass : grass : wheat.

Grass-Arable Rotation.—In these rotations the majority of the leys are left down for long periods, from four to as many as twelve, or in some cases even more, years. Most usually as much as three-quarters, or even more, of the farm will be in leys at any one time. Ordinary animal products are the major concern of those following the grass-arable rotation, and it is on these farms that dairy bailing, poultry and pig folding are often such important and telling features of the system. Grass-arable farms at a moment's notice can be turned over to cereal production on a grand scale and hence, if for no other reason, the enormous importance of the system and of farms conducted on this system to our national welfare. What is achieved by this system properly conducted is to farm without wasting a gallon of urine or a blade of grass ; it marries the animal to the soil as can no other system, and ensures that the sod performs its maximum functions in respect of soil fertility and crop production, and the sward its maximum function in respect of animal production. The nation is under an incalculable debt to Mr. Hosier and his followers, and this will eventually be realized, for it is not so much what the Hosierites do on their own acres as the principles which underlie their activities.

To the credit of ley-farming as a whole is to be placed the fact that it makes heavy, or at least reasonable, demands upon labour ; it is less dependent upon imported feeding stuffs than most other systems, and it maintains its acres and its practitioners in a condition of maximum flexibility and ready for anything.

Nondescript.—In so far as acres are concerned the nondescript system is the one I should imagine most generally practised in England and Wales. I mean when a man practises ley-farming or arable-farming on one corner of his farm, and maintains the rest in permanent grass. Such a system is not incompatible with reasonably high production, but it is under this system that we see some of the worst examples of slovenly, negligent and deplorable husbandry. Our nondescript farms stand as a token of the fact that a system of farming by which under present conditions a farmer may contrive just to keep body and soul together is likely to be a system completely out of harmony with the needs of the nation. Many nondescript farms are family farms, and the amount of tillage is a function of the size of the family, or of the number of sons willing to stay at home—both dwindling in number.

Permanent Grass.—The permanent grass farms are those upon which there is no cultivation of any kind : on some it is still possible to find a plough, but only as a museum specimen. The number of permanent grass farms has demonstrably increased ; such farms are apt to be run together, when generally fences will be more

then ever neglected and the whole (and too large) unit operated as a ranch. In the national interest, as I have defined and envisaged that interest, this system suffers from every conceivable defect. In the first place, speaking quite generally, the permanent grass farms contribute nothing more valuable than inferior hay to the winter ration ; they afford the minimum of flexibility, and maintain the minimum of acreage in a ploughable condition. Permanent grass farms serve as an excuse for an immense amount of national and private laxity, because in brief, however bad they are they generally have some slight earning capacity, and that with the minimum of trouble to anybody—landlord, agent or farmer. Thus these farms frequently stand on land in urgent need of drainage and of lime, and so in the main they continue to stand.[4] It is perhaps the greatest tragedy of British agriculture than even the poorest of poor grass has some earning capacity. Milk production on permanent grass farms, and especially on those deficient in lime and phosphates—and they are many—and particularly where the stationery night paddock figures prominently in the management, stands as the best example I know of ultra-dependence on imported feeding stuffs and exaggerated waste of the manurial residues from such feeding stuffs : waste as such down the drain, and waste because of extraordinarily inept grassland management (on this latter point I will enlarge in a moment) ; waste also of the potential fertility tied up in the sods of the night and other more heavily dunged and urinated paddocks.

At this point I would urge that unless we know the number of farms and the gross acreage of such farms operating on each of the four systems I have enumerated we know next to nothing as to how this country stands relative to potential food production. Furthermore, schemes for helping the farmer *via* commodity subsidization and by planned marketing cannot be assessed in their influence on the maintenance and enhancement of soil fertility—and that is what matters above all things—unless we know the systems of farming under which the assisted commodities are being predominantly produced. How much quota wheat, for example, is being produced respectively on arable farms, nondescript farms, or on ley farms ? Where is most of the milk being produced—and this is a matter of fundamental national importance in the interest alike of the health of the cattle and of the children of this country—on nondescript farms, permanent grass farms, or on ley farms ? Where is most of the permanent grass of the country, and where is the best and where the worst—on nondescript farms, or on permanent grass farms ? These are all essential facts to be known in the formulation of a long-term national policy for agriculture. The facts are only on the land, the agricultural statistics cannot give anything approaching a full answer to any one of these questions. The answer to these questions, and to equally important questions connected with facilities at the farmstead and over the fields (watering, drainage, and the condition of fences) can

[4] Rice Williams (**10**) has estimated that the permanent grass and arable land of Wales alone require at least 1½ million tons of lime to bring the lime status to a satisfactory level. The distribution of lime for England and Wales together under the Land Fertility Scheme has not, up to date, been materially in excess of one million tons.

be given only by a properly conducted survey carried out over the whole country and on a uniform plan. Map also the type or class of all the rough grazings and permanent grass (in a manner broadly similar to the survey of Wales recently undertaken by my department), and map the ploughability of the several fields: then, and only then, should we know where we stand. To conduct such a survey would be a relatively simple matter. To my mind, until such a survey is put in hand, and the lessons of the same—cruel and bitter the lessons will be—duly digested, there is little hope that the country at large will realize either the deplorable condition of our acres or their immense potentialities. The first necessity from all points of view—that of the statesman, the townsman, farmer and countryman, in short, that of the nation—is literally and in fact to put rural Britain on the map.

Only when rural Britain is on the map shall we be able amongst other matters to decide where in the national interest it is desirable to extend arable farming, and where ley-farming, and where it may be necessary or permissible to tolerate nondescript and permanent grass farming.

Having discussed systems of farming and levelled certain well-founded criticisms against nondescript and permanent grass farming, I am now in a position to unloose a whole barrage of criticism against permanent grass as such: and note this, the case for ley-farming is implicit in almost every word of just criticism that can be levelled against permanent grass.

My criticisms of permanent grass are general and particular; here are my general criticisms. The psychological influences of permanent grass go much further than I have already indicated; of course there are clever managers of permanent grass, but I doubt if even the best practitioners are on a par with the most proficient arable and ley farmers; while speaking generally, the standard of management of permanent grass, I should say, stands to the management of arable land, taking the country as a whole, as certainly not more than 60 (and probably hardly as much as 40) to 100. Leys as long as they continue to be managed as such are almost invariably managed better than permanent grass; they are both easier to manage properly and the inducement so to manage them is greater.

My next general criticism is that of the veterinarians who are telling us with a voice that becomes daily louder and more united that permanent grass harbours many of the organisms of disease.

My next, because as I have already said an enormous proportion of our permanent grass is in urgent need of lime, a need that becomes ever more serious in view on the one hand of extended milk production, and on the other of the movement in the directon of rearing and slaughtering increasing numbers of young animals. There is only one correct and entirely satisfactory way to apply lime, and that is under the plough, and I think this fact alone is sufficient to condemn not thousands, but at the very least three million acres of ploughable permanent grass, mostly quondam arable, in England; in Wales to my own certain knowledge it is enough to condemn something over 700,000 acres.

My last general criticism of permanent grass is that good young grass properly

conserved can be made of immense value to help out the winter ration. Grass silage (and probably dried grass also) is bound eventually to come into its own. Bad grass cannot, however, make good silage or good dried grass, while everything is to extend the season over which it is possible to dry grass and make silage—special purpose leys can help enormously to this end.

My particular criticisms of permanent grass, considered as grass, are these. Even the best permanent grass is far too weedy and much more weedy than first-class leys, and the best permanent grass has a shorter growing season than can be arranged for by a sequence of good leys. Exceedingly productive leys can be maintained on soils incapable of holding and incapable of being made to hold good permanent grass.

I want first to say a little about weediness, and this will lead naturally to the consideration around which the strongest case for ley-farming on grounds of pure husbandry is to be made.

Weediness makes for uneven grazing—witness, for example, the effect of buttercups; it therefore makes for a waste of valuable material; it also makes for an uneven spread of urine which cannot be mechanically rectified. Because of this, and for another reason now to be explained, weediness or any tuftedness in a pasture reacts against the enhancement of soil fertility, as well as causing the waste of edible material.

My 'other reason' is that herbage returned to the soil through the animal, provided the lime and phosphate status of the soil is maintained at a proper level, leads to greater soil enrichment and productivity than when such herbage is allowed to rot back, a fact which has been shown by numerous experiments conducted at Aberystwyth[5] and which tends to add emphasis to the teaching of our own and other experiments, as, for example, those of Mr. Martin Jones, on the profound influence of night paddocking and of any even slight robbing of Peter to pay Paul. These experiments, coupled with observations over a great number of years, particularly striking phenomena now presenting themselves on the lands where we are conducting our Cahn Hill experiments, force the conclusion upon me that urine has a virtue greater than is fully appreciated, and a virtue that reveals itself on land no matter how generously manured with what have come to be regarded as standard dressings of CaPKN. Consequently any system of grassland management, or for that matter of farming, that does not make the best use of what Mr. Bruce Levy of New Zealand has so aptly, but possibly one-sidedly, described as stock nitrogen, is open to grave criticism.

Because of weediness, tuftedness and uneven grazing, and of herbage never converted, and because of night paddock and quasi-night paddock effects, stock nitrogen is wasted, or uneconomically distributed, to a far greater extent on permanent grass than on leys, it is so wasted, and often to an exaggerated extent, on even the best fatting pastures, and particularly so when watering arrangements are ill arranged. The matter, however, goes much further; the fertility accumulating under the best

[5] Experiments now in progress at the Welsh Plant Breeding Station, and see (6)

grassland (permanent grass and leys alike) becomes in excess of what can be cashed from the grass-clover covering. All very old sods become in effect, and to a greater or lesser extent, pot-bound, with the result that the plant covering is incapable of reacting in full measure to the inherent fertility of the soil, while to plough, aerate and lime (where necessary) is to give life to favourable biochemical changes and further to enhance the productivity of the soil. The best grassland holds within itself an immense store of arable potentiality, while the soil rejuvenated by ploughing and aeration, even after yielding several white straw or other crops, can be put back to ever better and better grass. That is the experience of every competent ley-farmer, and ley-farming is creeping into ever better and better permanent grassland.

To plough up an old sod full of white clover, and one that has carried an abundance of stock, and therefore which has been well impregnated with stock nitrogen, and to harrow lime into such upturned sod, is to make and spread a compost at one operation. This, in short, is to mix with the soil three essential ingredients, vegetable and animal residues, and lime, and under conditions most conducive to favourable biochemical activity. It is the arable or crop-producing attributes of sod that I maintain constitute the strongest case for ley-farming, for without the intervention of cropping the full fertility value of superb sods can never be cashed.[6]

At the other extreme—the poorest soils—there is nothing to match the continued ploughing down of sod, accompanied by adequate liming and phosphating, to build up fertility. In my own experiences of land improvement gained on what must be some of the poorest soils in Britain, as well as on soils of great inherent virtue, I have been astonished at the progressive improvement in sward and carrying capacity attained when three or four four-year leys have been ploughed down in succession (each sown on the upturned sod of its predecessor) without the intervention of a removed nurse crop or of a hay crop. The sequence here is all grass, all grazing and stock nitrogen the whole way, the plough being called in only to assist in compost-making and to ensure adequate admixture of lime, phosphates, organic residues and soil, and to prepare the way for the sowing of the sequential leys. By the adoption of this procedure over a sufficient run of years it is possible to bring land of a most unpromising character into a condition capable of maintaining a rotation balanced between leys and white straw and other crops.

There is nothing new in the idea of sowing down immediately on the upturned sod, just as there is nothing new in the idea of ploughing up grassland as a means of improving it. Marshall as long ago as 1789 remarked, ' Old pasture lands overrun with ant-hills and coarser grasses are not easily reclaimed without the powerful assistance of the plough.' The idea of the all-grass rotation perhaps, however, has an air of novelty about it ; wild white clover as a commercial commodity is comparatively novel ; cheap phosphatic manures are comparatively novel ; the tractor

[6] It is true that it is sometimes difficult to utilize the richest sod to the best arable advantage because of wireworm and the lodging of cereal crops. Much remains, however, to be achieved in the direction of the breeding of short stiff-strawed cereal varieties, while in so far as cereals are concerned wireworm is not so destructive after properly managed leys as after permanent grass.

and modern implements are a recent novelty, and more recent are the improved and leafy strains of grasses—all these taken together, if they are to be used to best advantage, must inevitably spell novel rotations. One of the greatest merits of improved technique based on modern facilities for putting down leys on upturned sods, and without resort to covering crops, is that by the periodic adoption of this method (that is to say, as and when necessary) the farmer is enabled to take his leys around the farm sufficiently quickly and before there is any sward deterioration, and in sympathy with the lime demands of his animals and the lime requirements of his soil.

It is somewhat remarkable that so little exact experimental or statistical evidence exists for comparing the yield of leys, either in grass, milk or meat, with permanent pastures on similar soils and under precisely comparable conditions. We have Mr. Roberts's evidence from Bangor (**2** and **3**) which is in favour of the ley, and not a little evidence from Aberystwyth, also in favour of the ley (**7**). Evidence from grass lets favourable to the ley has also been brought forward by various authors. The most convincing evidence, however, is the performance and experiences of competent practitioners in the art of ley-farming, and thus the results of investigations and inquiries conducted by Mr. John Orr, lately of Manchester University, are particularly informative and are wholly in favour of the ley (**1**).

At present I am engaged upon collecting the material for writing a book on ley-farming. As a preliminary I sent out a questionnaire and have had a most helpful and gratifying response from farmers. The evidence from the replies received is overwhelmingly in favour of the ley, great stress being laid on the improved quality and stock-carrying capacity of the ley grass compared to the quondam permanent pasture, and the extended grazing season provided by the leys. The leys would seem, however, to have justified themselves not only in an extended grazing season, but by virtue of giving grass at periods within the grazing season proper when owing to weather or other conditions grass is liable to go short. Thus Major Dugdale of Llwyn, Montgomeryshire, who is rapidly and methodically (at the rate of about fifty acres per annum) converting the permanent grass of his farm into a sequence of leys by the methods I have discussed, informs me that during the early and unprecedented drought of this year the leys were invaluable, 'and thanks to them my ewes and lambs which had a turn at them all have done better than usual and have not suffered from the drought.' Mr. R. L. Muirhead, of Borsdane Farm, Westhoughton, Lancashire, who is well known for his enterprise in ley-farming, speaks equally highly of the value and performance of his leys during the past critical months, and particularly interesting is his remark that 'the younger fields stood up to the dry conditions better than the others, and the youngest of all (sown last August) with Italian ryegrass has done best of all.'[7] Mr. Wilks, of Whartons Park, Bewdley, Worcestershire, who after prolonged attempts at improving the poor permanent grass on his farm is now rapidly getting into the ley system, says that during the latter part of 1937 the whole of his grazing came from leys and newly grassed areas. The old

[7] This performance of Italian ryegrass is confirmed by results obtained for the past four years with Italian ryegrass at the farm of the Cahn Hill Improvement Scheme.

permanent pastures did not recover from the late summer and early autumn drought of that year, and the leys carried all the stock from July onwards. During the drought of this spring his position was never difficult, the maiden leys providing an abundance of good pasture, and these after being grazed into May will be mown for hay.

In a recent letter to me Mr. Wilks concludes with this peculiarly significant statement : 'An interesting sidelight is that the arable crops on land recently ploughed out have stood the drought much better than those on the stale old arable . . . the whole thing is complementary and balanced.'

The experiences of Colonel Pollitt, of Harnage Grange, Cressage, Shropshire, are in keeping with those of Mr. Muirhead and Mr. Wilks. Colonel Pollitt has also sown out early in May without a nurse crop and has been able to start serious grazing (ewes and lambs) in the first week of July, thus obtaining valuable young grass at what is often a critical time of the year. On a field thus treated Colonel Pollitt also wintered cattle continuously from November 1 to May 1, and he informs me that there was no poaching except at the gate.

The ley, furthermore, affords great scope for special treatment with a view to providing grass when it will be most wanted. Ley grass put up for the winter carries green and protein-efficient into February, March and April altogether more effectively than does permanent grass, and this is perhaps one of the greatest merits of the ley, and a merit which by virtue of further research in plant breeding in the direction of producing winter green and winter growing strains is likely to become increasingly pronounced (**8**).

The employment of different seed mixtures with a view to giving grass more particularly at different and explicit periods of the year affords additional scope to the ley-farmer. Thus at Aberystwyth we have found that a mixture consisting predominantly of Danish meadow fescue and Aberystwyth S.48 timothy gives exceptionally good grazing during July and August. On this and similar points there is, however, need for greatly extended investigation.

I have now made my case for ley-farming, but I am not at present claiming that all permanent grass should be brought under the plough ; before that claim could be substantiated we want a proper survey and a great deal more experimenting. Apart from steepness, boulders and such like, low rainfall and heavy clays present their special problems. As to the clays, the fact that it is a perfectly sound procedure to re-grass immediately on an upturned sod makes a lot of difference, as does the soundness and feasibility of the all-ley rotation, while we have the tractor and modern implements. To make it possible to establish leys without undue risk of failure on the heaviest soils is to-day, I feel convinced, only a matter of sufficient experimenting as to ways and means. The same is, I am sure, largely true of establishing leys in regions of low rainfall. Mr. Mansfield seems to have no difficulty in establishing excellent leys in this district not remarkable for its high rainfall, while everybody who farms on something akin to the four-course rotation after all establishes leys. What is wanted in order to establish a foolproof and almost weather-proof technique

is much more experimenting. There is a right date to sow for every district, while in the driest areas I doubt the wisdom of sowing under a nurse crop, for the quicker growing cover crop must compete exaggeratedly with the slower growing seedlings for what little moisture there may be. It may be unwise under such conditions to include even Italian ryegrass in the mixture, for this is always by far the quickest grass seedling to get off the mark, while it would seem to be of supreme importance to obtain a scrupulously clean seed bed, and to bring in the mower at the first sign of weeds gaining dominance. The successful grassing of new golf courses in regions of low rainfall, I think, holds valuable lessons for the would-be ley-farmer—' put as little as possible to compete with the grasses you ultimately want ' would seem to be the teaching. I would again emphasize that it is not sufficiently realized that a ley sown without a nurse crop very soon starts earning money on its own account, and where 4-6-8-10 year leys are at stake it is poor economy to jeopardize the whole for the sake of a preliminary cash crop.

I cannot conclude my address without a little more detailed reference to the ley itself. The chief points at issue are how to establish it, what to sow and how long to leave it down. Not one of these questions can be answered in general terms, but there are in each case fundamental principles at stake. The fundamental principle relative to duration is the fertility attributes of the sod. From that point of view, and considering alike soil condition and manurial residues, my friend Prof. Robinson (**4**) in the informative letters he has so kindly, and if I may say so, attractively, written for my major enlightenment, would seem to agree with me that there is everything to be said for the four-year ley, ending, as I would wish to insist, with at least two years of honest hard grazing, with urination and spread of white clover. The general principle here is ' to plough down the sod before it has by one jot deteriorated.' It has, however, to be remembered that grazed swards do not leave behind them a sod with a deep-going root system ; hayed swards develop a deep-going root system. In the interest of general fertility and soil condition I hold that it is sound practice, ever and anon, to plough down sod with a deeply penetrating root system. Now from the point of view of hay production, the highest yields are obtained from leys in their first and second harvest year—that is to say, as long as late-flowering red clover lasts. In general my view is this, that the best practice founded on scientific principles would be to employ 1-2 year leys for hay and 4-6 year leys for grazing only. The three-year ley is rather like the dual-purpose animal. Although it is a brave southerner who would criticize Scottish practice, I am inclined to criticize excessive dependence on dual-purpose (hay-grazing) three-year leys. I would rather have a sequence of 1-2 year deep-rooting-hay leys following after four-year-white-clover-replete-shallow-rooting-grazing leys. This procedure would give more hay, more grazing and more fertility. With apologies to Aberdeenshire, that is my considered opinion. In any event my criticism of the very best practitioners of ley-farming is that they do not use leys of different kinds for different purposes, and do not rotate all the different sorts of leys after each other all round the farm to anything like a sufficient extent, for it is thus, and only thus, that all-the-year-round

grazing is to be obtained. This is too large a subject to discuss in detail here, but it is one demanding much thought and much agronomical research.

In passing I might say that in my view no problems so much as those of grassland demand prolonged and large-scale agronomical investigation. I would wish to distinguish between, on the one hand, agronomical research, and on the other, scientific research as normally understood and conducted. The major aim of agronomical research, which is essentially field research, is to study all the factors which are operative at once and together, and in their natural interplay, for ‘ nature is a theatre for the inter-relations of activities.’ Such a procedure, it may be said, is impossible, or at least unscientific. It is certainly not impossible, and if it is unscientific it will yet remain agronomical, and many of the problems of agriculture are more likely to be solved, shall I say, by agronomical investigation than by scientific research, while nearly all the results of scientific research have to pass through the sieve of an immense amount of agronomical investigation before they can be made useful, and in some cases perhaps before they can be other than positively dangerous to the practitioner. The technique of agronomical research entails a great deal more than blindly following all the elaborate rules and regulations laid down by the statisticians; indeed, such rules and regulations are of no fundamental significance in the proper planning of an elaborate series of field experiments. They are sometimes, but by no means always, useful in the actual placing of plots on the ground, and they are sometimes essential, but are by no means always necessary, in the examination of quantitative data. One effect of the modern glorification of statistical methods has undoubtedly been a tendency to obscure the wood for the trees, to concentrate on the part, often an isolated part (yield, for example), instead of the whole ; and, worse still, to fill the agronomist with a medley of complexes and inhibitions which have reacted adversely on the development of a technique adequate to solve a large number of the problems that can be solved only by highly complicated field experiments. Many agronomists are almost too frightened to set up the sort of experiments their experiences teach should be set up, because they are timorous lest the data could be made amenable to statistical analyses. Agriculture would have been the gainer if the agronomist had never been taught to be timorous, and if he had plodded away undeterred and undismayed at the details of his own technique, when by now perhaps he would have been able to justify his claim that what is primarily wanted to-day is enormously increased facilities for the conduct of field experiments in contra-distinction to field trials and demonstrations. That at least is my claim, for I claim to be an agronomist, and in that capacity one who has been responsible for the setting up of hundreds of weird little field experiments involving in all literally thousands of plots.

As always, however, the greatest and the final hope is the farmer himself, for he at least is untrammelled by the technique of science, and is not a slave to the fashions current in science, while his major training is not in collecting data, but in the gentle art of unadulterated observation. Just because, therefore, of the immense accumulation of scientific knowledge, so much of it but half digested in the practical

sphere, never so urgently as at present has there been such a necessity for an abundance of well-informed, originally-minded and affluent pioneers, men willing and eager to transgress against every canon of good husbandry, and to explore, and almost *de novo*, the whole field of rotation of crops, and the whole idea of rotation of pastures of different types and of stock over the surface of the farm.

This has been a long digression; it has, however, been relevant to my theme, and it has been on a question of undeniable importance and about which I think I am entitled to express opinions. I will now return to the ley.

Grazing management affects the permissible duration of the grazing ley to a marked degree. Thus he who bails cattle or folds poultry can keep his leys down much longer than the ordinary farmer who thinks he is grazing intensively, but in fact is doing nothing of the sort; only the close folder, or the tetherer, really grazes intensively, and by intensively I mean without waste of any sort. But even under the cleverest management sooner or later the sod will begin to become pot-bound, and according to soil type, bent, soft brome, Yorkshire fog, weeds or moss will proclaim the need of the plough and a new start.

What to sow and how to establish are in the main twin problems—twin to this extent, that what to sow is determined much more by every shade of after-management that it is proposed to follow than by soil type; the trouble here is that agricultural chemistry has such a terribly long start of agricultural biology. Grassland, like every crop the farmer handles, is the plaything of soil, climate and the biotic factor; with grassland the master factor is the biotic—that is to say, what man himself does with his animals. One, and the most obvious, example will suffice—the use and abuse of Italian ryegrass. Italian ryegrass is essentially a grazing grass; if allowed to grow away in a hay mixture it will smother and depress other and higher yielding hay grasses. It should therefore be included in hay mixtures only when such mixtures will be grazed long into the spring or early summer, and when after a small and herby hay crop aftermath is of prime importance. Italian ryegrass is of its greatest value for sowing with grazing mixtures put down on an upturned sod. The aim here is two-fold; firstly, to bring treading feet and urine on to the developing sward as soon as possible—this is the function of the Italian ryegrass; and secondly, to encourage the spread of wild white clover as rapidly as possible—this is the combined function of light (keeping the Italian ryegrass in reasonable subjection), the treading feet and the urine.

The so-called indigenous strains! Badly called, and I am afraid that I have been largely responsible. In the few words I have to say on this subject I will confine myself to the Aberystwyth bred strains, for here at least I am talking about something definite and about which I myself at all events may be supposed to know something. For the sake of brevity I will lump the findings of all our experiments, and of all my own experiences, and those of my colleagues, into a single short paragraph.

For the ordinary three-year hay-pasture ley on medium-good soil, postulating the inclusion of wild white clover and good urination, the Aberystwyth pasture and pasture-hay strains are by no means an absolute necessity, but in reasonable amount (say up to about one-fifth to one-third of the ryegrass, cocksfoot and timothy con-

tribution) I recommend their inclusion for the sake of the extra late grazing they will give, and to add leafiness to the hay crop. For leys of four years and longer duration, I believe a contribution of Aberystwyth pasture or pasture-hay strains of not less than one-third of the contribution of ryegrass, cocksfoot and timothy always to be justified. On really poor soils and for re-grassing derelict grasslands there can be no question as to the absolute necessity of including the pasture and pasture-hay strains. On our Cahn Hill lands and elsewhere, we have made quite remarkable swards by using such strains wholly, or up to two-thirds of the mixture, where with the non-pedigree bred strains it has been impossible to establish a sward capable of maintaining itself for more than twelve months. You will note I have talked explicity of the Aberystwyth pasture and pasture-hay strains. We have now early hay strains coming on such as Dr. Jenkin's S. 24 perennial ryegrass, his S. 51 timothy and my own somewhat modified S. 37 cocksfoot, which will I think vie with the ordinary seed of commerce in earliness and bulk during the first and second harvest years, and which are much more leafy. The matter here will turn almost wholly on the relative cost of the pedigree and non-pedigree seed, for manifestly an expenditure on seed that would be abundantly justified for a four- to twelve-year ley might not be an economic proposition for a one-, two-, or three-year ley. If, however, the hay strains ultimately prove themselves to have sufficient virtue they are bound in due time to replace the ordinary commercial strains, and in fact by a process of substitution to become in effect the ordinary commercial product. This I think will be the destiny anyway of Dr. Jenkin's S. 24 ryegrass, for as well as being early and relatively leafy it gives much better July-August grazing than the ordinary Irish and Ayrshire ryegrass.

In this matter of the Aberystwyth strains, however—such is the deeply penetrating influence of psychological factors—I can have no cause for complaint if you deem it well to regard me as a prejudiced witness, but if you so regard me, please yourselves be sufficiently broad-minded to come and see our trials, or go and have a look at one of those which with the help of the Royal Agricultural Society we are setting up in various English counties ; or better still, experiment for yourselves under your own, your very own, *scheme of management*. It may be that management in some cases is so superbly good that it hardly matters what a man sows, while in others it may be so supremely bad that no proper use can be made of a good thing when a man has got it.

I am afraid I have adopted an unusual course in my approach to my subject ; I have not followed normal practice, for instead of reviewing the data and evidence available I have in effect reviewed my own reactions to the implications of the work with which I have been connected for the past twenty-five years and more. Perhaps I need not apologize for this, for after all facts and data are of no practical use until people grapple with the practical implications. Instead of my 'facts'—and scientific 'facts' are not always correct—I have put my grapplings before you, that is all, and if justification is necessary I think sufficient justification is the admittedly deplorable condition of a huge acreage of this country, the dilapidated condition of many of our farms and farmsteads, and the therefore necessarily backward state of much of our farming. Two needs seem to me to be crystal clear : first, the conduct of a survey on

the land—and I believe every agricultural scientist, though perhaps not every farmer and every economist, would agree to 'on the land' somewhat on the lines I have suggested—and then the ways and means of getting the plough into the grasslands that the survey conclusively proves ought to be ripped up. Working capital, and the correct expenditure of that working capital, is in the last resort the only solution for our derelict and quasi-derelict acres.

I like the American idea of loans with a working plan; of loans with advice. I do not believe that the history of the years since about 1894 shows that the spasmodic periods of agricultural prosperity that have on occasion intervened have been responsible for a great deal of land improvement, or for a proportionate improvement in the equipment necessary for productive farming. Prosperity as such in agriculture, as in industry, is to a large degree a function of equipment, for without the necessary equipment it is impossible to farm economically, just as it is impossible to manufacture economically.

Again, it is unreasonable to expect that a man devoid of working capital, and probably the son of a man similarly devoid, should have all the knowledge of how best to farm, and particularly of how best to improve land (in which art he will necessarily have had no sort of experience), in sympathy with adequate working capital suddenly provided for the purpose. Advice, and some measure of control, must necessarily go with credit facilities, and in so far as breaking up grassland is concerned I like still better the American idea of group loans, and of a 'master borrower.' The 'master borrower' in this case would be set up as a contractor with tractor and necessary equipment to break up the grasslands, for it is important to remember that ploughing up of this sort is essentially tractor work, that it interferes with the normal routine of an ill-equipped farm, while tractors are to all intents and purposes non-existent in many of the districts where wholesale ploughing up is most necessary. My own experiences are interesting in this connexion. We tested the desire for contracting last year, and had three times as many applications as we could fit into the acreage we could do, while now, and because of the demand our work has created locally, a lorry contractor in the neighbouring village has acquired a tractor, and is fully engaged on contract ploughing.

I like also the American idea of being boldly eclectic and scheduling particular districts as being eligible for their rehabilitation loans; indeed, I was foolhardy enough to make a suggestion very much on these lines in my book *The Land Now and To-morrow* (**5**). There are innumerable districts that should be similarly scheduled and similarly helped in this country, but always through financial help *cum* technical advice terminating in an agreed working plan; and here again my own experience comes to support my contention, for in those cases where contracted we did so only when the farmer agreed to follow all our advice as to subsequent operations, manures and seeds, to the letter, and in all cases the farmer has done so, and demonstrably to his own advantage.

The breaking up of derelict grassland is to be helped forward not only by loans, but by a reorientation of such working capital as the farming community possesses

and also, I think, by a reorientation of the monetary and other arrangements existing between landlord and tenant.

Ley-farming in my view affords great scope for such reorientation, for it would make possible, and on a general scale, a variety of methods of share farming. For example, one might conceive of a mechanized wheat grower operating over a large number of neighbouring ley farms on a share basis ; another man on a share basis might be running the poultry, the proprietors themselves being primarily interested in the adequacy of the rotation and farming operations, and possibly in one major product—milk, shall we say ? By this means farmers should achieve a better return on such working capital as is available, and also the nation should achieve a more balanced specialization between farming *qua* farming and commodity production and disposal. Landlords themselves with advantage could often think out methods of sharing-in with their tenants and ley-farming opens many avenues of approach to such sharing-in, but in any event it behoves the landlords of many districts to be alive to changing times, and to be ready for the day—not, I think, far distant—when better tenants will be found for farms which are going concerns on the ley-farming basis than for those which are nondescript or permanent grass. It may thus prove to be a wise policy to adjust leases, and even financially to assist purposeful tenants towards that system of farming which will accord best with the trend of national and international events.

Let me insist, in conclusion, that the affairs of agriculture, slowly moving as they necessarily must be, are ill adapted to respond to the dictates of any immediate expediency, for expediency is ever shifting, and at the best ' is the mere shadow of what is right and true.' To be ever prepared for change in a world that is ever changing can be the only possible basis for a sound agricultural policy for this country, since we are so peculiarly liable to be crucially affected by happenings beyond our own control, beyond our own jurisdiction and beyond our own borders.

References

1 Orr, John. Grass and money. *Scot. J. Agric.* 20. 31-40. 1937.

2 Roberts, E. J. I. The effect of wild white clover on the live weight increments from a temporary pasture. II. A comparison of temporary and permanent pasture. *Welsh J. Agric.* 8. 84-93. 1932.

3 ——— Comparison of (*a*) an old with a temporary pasture and (*b*) two temporary pastures from one of which wild white clover had been omitted at seeding down. *Welsh J. Agric.* 11. 132-9. 1935.

4 Robinson, G. W. Mother Earth, being letters on soil addressed to Prof. R. G. Stapledon. London, 1937. pp. 210. pl. maps.

5 Stapledon, R. G. The land, now and to-morrow. London. 1935. pp. 354. pls. 2 maps.

6 ——— The improvement of grassland. *J. Bath W.S. Co. Soc.* 12. 7-23. 1937-38, or *J. Minist. Agric.* 43. 308-10. 1936.

7 ——— The Hill Lands of Britain. London, 1937. pp. 138.

8 ——— Immature grass and young swards. Part I. *J. Minist. Agric.* 44. 317-29. 1937. Part II. *J. Minist. Agric.* 44. 442-9. 1937.

9 ——— Agricultural Policy. *The Fortnightly.* March, 1938.

10 Williams, Rice. The growing danger of lime depletion in Welsh Soils. *Welsh J. Agric.* 13. 246-55. 1937.

UNITED STATES REGIONAL PASTURE RESEARCH LABORATORY

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General Characteristics of the Region

The United States Regional Pasture Research Laboratory is located in one of the most important milk marketing regions in the world from the standpoint both of production and of consumption. The officially designated " North-eastern Region " embraces the states of Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont and West Virginia. The pasture problems in this Region are similar to those in the greater region comprising the north-eastern quarter of the United States and certain adjoining areas in the Dominion of Canada (see Fig. 2).

The soils of this greater region are for the most part of glacial origin, although residual soils derived largely from limestones, shales or sandstones are found in certain areas, particularly Delaware, Maryland, New Jersey, Pennsylvania and other states along the southern boundary. The soils vary from light sands to heavy clays and from unproductive to highly productive ones. The topography of the eastern half of the region varies from narrow plains and valleys to hills and mountains, while the western half, except along the rivers, is characterized by gently rolling to level prairies.

The climate is temperate. The winters are usually cold with considerable snow, and the summers hot and sometimes dry, particularly during July and August. The southern part of the region, as one would expect, has milder winters and receives a greater proportion of its precipitation as rain.

Most pastures in the eastern half of the north-eastern quarter of the United States are the so-called permanent pastures made up largely, insofar as the cultivated species are concerned, of *Poa pratensis* and *Trifolium repens* on the very productive soils and these species together with *Agrostis* species and *Poa compressa* on medium-productive and relatively unproductive soils. In addition to these species, *Phleum pratense*, *Dactylis glomerata*, *Trifolium pratense*, *Festuca* species and certain other species are frequently found in permanent pastures in some areas. In the extreme southern portion of the region, the Lespedezas are important constituents of such pastures.

The prairie states in the western half of the region also have permanent pastures similar to those farther east, but in these states a great part of the pasturage is derived from temporary pastures and aftermath. The term temporary pastures as used in this connection designates those pastures grazed for from one to a few years and then turned under for some other crop. Such a pasture is usually considered one of a

series of crops in a rotation and except for the method of harvest is treated and handled in a similar manner. In certain areas this type of pasturage is likewise found in the eastern part of the region. For this purpose the most important species are *Trifolium pratense* and *Phleum pratense*, although in some sections *Medicago sativa*, *Melilotus alba* or *M. officinalis* and *Bromus inermis* are used extensively. *Sorghum vulgare* var. *sudanense* alone or in mixtures is the most widely used annual grass to supply supplementary pasturage during July and August.

Purpose of the Laboratory

The United States Regional Pasture Research Laboratory was established under the authorization of the Bankhead-Jones Act, and is maintained at State College, Pennsylvania, by the United States Department of Agriculture, in cooperation with the twelve State Agricultural Experiment Stations in the officially designated " North-eastern Region." The Laboratory serves as the focal point for coordinating and integrating pasture research in the Region and as a research organization to develop basic pasture research along certain lines.

Coordinating Pasture Research

To help in bringing about a cooperative attack on basic pasture problems, the Director of each State Agricultural Experiment Station in the Region has designated one of his staff to serve as a collaborator with the Laboratory. In making up this group of twelve collaborators an effort was made to have various viewpoints represented, but with a common interest in pasture problems of the North-eastern Region. The group includes agronomists, soil chemists, plant physiologists, plant geneticists, dairymen interested in production and animal nutrition and a plant pathologist. The collaborators met for the first time at State College, Pennsylvania, on November 2 and 3, 1937, to help plan and discuss pasture research projects proposed for the Laboratory and to discuss those pasture research projects already underway at the various cooperating State Agricultural Experiment Stations. The collaborators will meet annually.

There will be a free exchange of project outlines dealing with pasture research between the Laboratory and the Agricultural Experiment Stations of the twelve north-eastern states which will serve to keep the various workers informed as to the research work in progress and that contemplated for the immediate future. In addition it is planned to have various members of the Laboratory Staff spend some time at the State Agricultural Experiment Stations actively engaged in pasture research and likewise it is expected that persons engaged in pasture research at the State Stations will spend some time at the Laboratory. This exchange of project outlines and visits will serve to uncover mutual problems and foster integrated or cooperative efforts.

Another step to attain a regionalized viewpoint on an attack of the pasture problems will be to bring together various subject matter groups to discuss specific problems and methods, and any other pertinent questions. One such meeting has

been held. The plant breeders of the North-eastern States interested in pasture improvement met in New York City, March 18 and 19, 1938. In addition to offering the opportunity for discussing specific problems pertaining to pasture improvement by breeding, the meeting served to clarify the functions of the Laboratory in the regional program. A committee report was adopted which pointed out that the Laboratory should be concerned primarily with fundamental research such as the range and nature of variation within species, relative effectiveness of different methods of breeding, cytogenetic information and other topics of general interest. Breeding grasses or legumes for specific localities should for the most part be carried on in the localities where the strains are to be used.

Research and Facilities

The research activity of the Laboratory itself has been developed primarily along two general lines, namely (1) the cytogenetics and breeding of pasture plants in the North-eastern United States, and (2) the composition of pasture grasses and legumes and their response to certain environmental treatments.

The technical staff at present consists of a plant chemist, a soil chemist, a plant physiologist, two geneticists, a cytologist and the Director. A plant pathologist was added to the staff on July 1, 1938.

The physical plant of the Laboratory (see Fig. 1) consists of a two-storey brick building with basement. The first and second floors contain five laboratories, six offices, a conference and library room, a photographic dark room and a seed storage room. In the basement is a grinding room, drying room, two low-temperature rooms and miscellaneous storage space. The building was completed July 1, 1937. The brick headhouse contains a potting room, two small laboratories, two offices, a storage room, and a combination garage and work room. Attached to the headhouse are two glass houses each 100 ft. by 32 ft. The greenhouses and headhouse were completed December 1, 1936. Another greenhouse approximately 122 ft. by 35 ft. will be built during 1938. In addition to the buildings and equipped laboratories, as much as forty acres of land are available for a nursery and experimental plots. At present about fifteen acres are being used as a plant nursery.

Breeding and Cytogenetics

During the early development of the breeding program considerable attention has been given to assembling plant material. In 1937 approximately thirty-five thousand individual plant seedlings were grown in the greenhouses and transplanted to the nursery. Seed for this material was collected from old pastures in the North-eastern Region through the help of cooperating agronomists and from commercial growers of *Poa pratensis* and *P. compressa*. These two species, together with *Trifolium repens*, constituted the bulk of the planting. Other species included were *Agrostis* spp., *Dactylis glomerata*, *Phleum pratense*, *Lolium perenne*, *Festuca* spp., and *Trifolium pratense*. During the late summer of 1937 approximately fifteen hundred sod plugs were collected in the Region from old pastures which were considered at

least fairly well managed. Isolations of every species in each plug were made during the spring of 1938 and transferred to the nursery.

The individual plants resulting from the seeds and clones are being studied primarily for the purpose of ascertaining the range of hereditary variation exhibited within species. At the outset an attempt is being made to determine the relative value of individual plants when increased clonally and grown in small plots by studying their response to clipping treatments. The grass clones are being grown in association with white clover and the white clover clones in association with bluegrass. As soon as time and facilities permit, it is planned to study some of the clones under actual grazing.

In the Laboratory's breeding program emphasis will be placed on methods rather than on attempting to produce a specific form or strain for a particular locality. It is, of course, hoped that improved strains will eventually be produced, but insofar as the Laboratory is concerned, the attempt to produce such improved strains will be undertaken jointly and cooperatively with the State Experiment Stations and in the area for which the improved strain is sought.

To help develop a sound breeding program there is need for additional cytogenetic information in regard to the various pasture species. The Laboratory will undertake studies of inheritance of specific characters and of chromosome behaviour in intraspecific and interspecific hybrids in diploid and polyploid species. The possibilities of inducing polyploidy both in staple species and in sterile hybrids will be explored. In this connection the alkaloid colchicine has given some encouraging results although these investigations are still in a preliminary stage. The nature and extent of apomictic reproduction among some of the *Poa* species, the cytogenetic basis of self and cross sterility and fertility particularly in *Trifolium repens* and *Lolium perenne*, are receiving considerable attention. Studies of controlled pollination, including the effects of inbreeding and outcrossing with various pasture species are underway. The results which have been obtained by depollination with hot water are sufficiently promising to warrant further investigations. Any applicable information obtained from these various studies will be used in connection with investigating the relative effectiveness of different types of mass selection and pure line methods, including hybridization, in the improvement of the pasture species in the Northeastern Region.

Another phase of a breeding program with pasture species is disease resistance. In the immediate future it is planned to initiate investigations into the nature, cause, and effect of certain diseases of pasture plants and to explore the possibilities of breeding for disease resistance.

Physiology and Biochemistry

Pasture research in the north-eastern states has been concerned primarily with measuring the effects on so-called permanent sods of fertilizer and lime treatments and of different systems of management. Incidental to these researches considerable attention has been given to technics for measuring responses without the use of grazing animals.

The environmental approach to the pasture problem at the Laboratory is being developed along two main lines, namely, (1) the chemical composition of pasture species and its modification by environmental or genetic causes, and (2) the response of pasture species to certain environmental influences, particularly light, temperature, nutrients and soil reactions. This work was begun less than a year ago, but it may be of interest to indicate briefly some of the preliminary explorations that have been made and the work contemplated in the immediate future.

In the composition studies an attempt is being made to determine the variation in chemical composition within a species. The content of cyanogenetic glucosides in *Trifolium repens* has been found to vary widely. Further studies on the nature of these compounds will be undertaken. The variation of the protein content of *Poa pratensis* is being studied and similar studies will be extended to other compounds and other species as time and facilities permit. A technic for building up various levels of reserves in the roots and rhizomes of *Poa pratensis* and *P. compressa* is being developed for the purpose of making subsequent studies on the utilization of these reserves following top removal.

The factors which control fruiting and vegetative activity in the pasture grasses present problems both in breeding technic and in pasture management. Some preliminary investigations have been made using light, low temperatures, different nutrient solutions and vernalization in attempting to induce fruiting. During the next few years it is expected that the temperature studies will be intensified and carried on with all the pasture species important in the North-eastern Region. Twenty-nine different clones of *Trifolium repens* have been studied in the greenhouse to determine what differential reaction there is in their ability to grow in soil at different levels of acidity and available phosphorus. A marked difference among the clones has been found.

Summary

In summary it may be well again to point out that the United States Regional Pasture Research Laboratory was established as a cooperative enterprise at State College, Pennsylvania, to serve as a focal point for coordinating and integrating pasture research in the region, and to carry on basic research along certain lines not already adequately provided for.

FIG. 1.—The laboratory building, headhouse and a small section of one greenhouse of the United States Regional Pasture Research Laboratory at State College, Pennsylvania.

FIG. 2.—Major Pasture Regions of the United States.

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PLANT REGENERATION AND PASTURE IMPROVEMENT UNDER ARID AND SEMI-ARID CONDITIONS IN SOUTH AUSTRALIA

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RAINFALL CONDITIONS OF SOUTH AUSTRALIA

THE State of South Australia, which occupies 380,000 square miles or one-eighth of the Australian continent, is characterized by a comparative paucity of rainfall.

The major portion—eighty-three per cent of the total area—is arid, and receives on the average less than ten inches of annual rain. A further 50,000 square miles, or thirteen per cent, receives between ten and eighteen inches, and can be classed as semi-arid, the mean rainfall season ranging from five to six months, with the remainder of the year normally subject to continuous drought. A limited area, about one half the size of Scotland, receives more than eighteen inches, with an effective winter rainfall season ranging from six to ten months of the year. Here, the majority of the soils in their unimproved condition are generally unproductive; but the use of suitable pasture legumes such as subterranean clover and lucerne, in conjunction with liberal dressings of soluble phosphate, and followed or accompanied by the seeding of permanent grasses, has resulted in greatly increased production.

PASTURE IMPROVEMENT IN THE AREAS OF HIGHER RAINFALL

The scientific investigation of pastures in South Australia has been confined for the most part to the area receiving more than eighteen inches of annual rainfall, including a limited irrigable portion. Within this area, approximately six major types of habitat have been defined; and for each natural zone there are now available improved seeds mixtures and methods of manuring which have resulted in marked increases in livestock production. Over this better rainfall area, the main problem at the moment is one of grassland management.

Sheep are the principal form of livestock in South Australia; and the total number carried is about eight million. Of these, nearly two million are located on the areas of saltbush and semi-desert scrub receiving less than ten inches of mean annual rainfall, whereas about 1.75 million are maintained on land receiving on the average ten to eighteen inches. Over the last twenty years, the total number of sheep in South Australia has increased by two millions. This is due entirely to increases on the relatively small area within the ten-inch annual isohyet, particularly in the areas of most liberal rainfall. The sheep population of the vast region of saltbush steppe and semi-desert scrub has decreased materially in recent years.

THE SEMI-ARID AND ARID REGIONS

The semi-arid area receiving ten to eighteen inches of rainfall carries in its

natural condition dwarf *Eucalyptus* scrub of the mallee type, much of which has now been cleared for wheat-growing. The persistent cultivation of a light soil, normally subject each year to six or seven months of drought, has led to a good deal of wind erosion, with the formation of numerous areas of drifting sand. There is a strong tendency towards the increased maintenance of sheep in this region, with a lengthening of the wheat rotation to permit a higher proportion of the land to be devoted to livestock. There exists a cogent need for scientific investigation of pasture establishment and pasture management within this semi-arid portion.

Over the extensive arid region of shrub-steppe and semi-desert shrub, sustained grazing by sheep and cattle, to which may be added the depredations of the rabbit, has led to widespread denudation, with consequent erosion of the soil and a marked reduction in stock-carrying capacity.

Gift for Research on Soil Erosion and the Regeneration of Pastures in Areas of Low Rainfall

Towards the end of 1936, a gift of £25,000 was made to the University of Adelaide by the family of the late Mr. Frederick Ranson Mortlock, for the purpose of research in connection with soil erosion and the regeneration of pastures on pastoral lands. The gift provided for a suitable building to be erected at the Waite Agricultural Research Institute, to be named the " Ranson Mortlock Laboratory." The foundation stone was laid in May, 1937, and the building occupied in March, 1938.

The new laboratory occupies a ground space of 110 feet by 45, and forms a wing at the northern end of the John Darling and John Melrose laboratories, to which it conforms in general structure and appearance. There are three floors, and included among its features are a library, a lecture room and two major laboratories, 41 feet by 24 feet in all four cases, laboratory accommodation for workers in agronomy and agrostology, bacteriology, spectrography and photography.

Investigations under Semi-Arid Conditions

Preliminary experimental work in connection with the problems of soil erosion and pasture regeneration has been commenced at Pallamana, a mallee centre, approximately fifty miles from Adelaide, which receives an average annual rainfall of twelve inches. A meteorological station established in 1937 provides for daily measurements of rainfall, evaporation, maximum, minimum, wet and dry bulb temperatures.

Two types of field investigation have been commenced. One constitutes an attempt to establish permanent pasture on a local area of drift sand ; the other involves the testing of numerous indigenous and exotic plants likely to be of value for pasture regeneration under low rainfall conditions.

It has been found that two plants in particular are likely to be of value in the reclamation of sand drifts. One of these is rye (*Secale cereale*), which appears to be outstanding among the cereals and grasses for providing a temporary cover under conditions of limited winter rainfall on an area of moving sand. Yields produced

on drift sand in 1937, with an effective winter rainfall of 6.21 inches, were as follows :

	Wimmera ryegrass	Barley	Rye
Mean yield of grain (bush. per acre)	—	0.01	3.21
Mean total yield of dry matter (cwt. per acre)	—	0.19	3.88

The second species of value is African pyp grass (*Ehrharta villosa* Schult.), which must be planted from roots, but spreads rapidly in sand by rhizomatic development when once established, and permanently stabilizes drift sand in an area receiving ten to eighteen inches of average total rainfall, of which approximately fifty per cent forms the effective winter rainfall.

Present investigations are designed to test the establishment of permanent herbage plants on a drift area temporarily stabilized by seeding with rye, and the influence of soluble phosphate and the seeding of additional pasture species on an area permanently reclaimed with pyp grass.

Another type of investigation concerns the cultivation of numerous indigenous and exotic species as single plants on a typical area of mallee soil. Of the indigenous plants tested, the various saltbushes and bluebushes, a number of which form the principal source of permanent forage in the arid regions of steppe country, have proved responsive to cultivation, and it appears that certain species such as *Atriplex vesicarium*, *A. paludosum*, *A. stipitatum*, *Kochia Georgii* and *K. tomentosa* can be grown for purposes of seed production in this area, should such an undertaking be desirable for the purpose of reseeding within the more northerly pastoral areas.

Species that appear to be suitable for cultivation as herbage plants within the semi-arid region above ten inches of rainfall are, perennial veldt grass (*Ehrharta calycina*), evening primrose (*Oenothera odorata*), creeping saltbush (*Atriplex semibaccatum*), Wimmera ryegrass (*Lolium* spp.), lucerne (*Medicago sativa*), barrel medic (*Medicago tribuloides*) and early-flowering subterranean clover (*Trifolium subterraneum*). Investigations are in progress with a view to the production of rhizomatic lucerne suitable for cultivation under these conditions.

Work Projected in the Arid Pastoral Region

Of the more arid pastoral areas to the north, very little is known as yet by the agricultural investigator. A primary need is an increase in the scope and comprehensiveness of the meteorological data recorded. One must also have a broad general inventory, along ecological lines, of the present condition of the vegetation. A major difficulty lies in the tremendous area to be covered ; and one can hope only to take sample areas of a representative nature and observe the effects of management and of various operations such as the ploughing of furrows and seedings of various types. The scope of the latter is limited, however, by the extremely low

value of the land; and it is probable that the investigation of biotic influences relating to livestock management will prove to be of greatest importance.

The Department of Botany of the University of Adelaide, formerly under Professor T. G. B. Osborn and now under the leadership of Professor J. G. Wood, has since 1926 investigated in great detail the plant associations of a heavily overgrazed area at Koonamore, in the north-east of South Australia; and has recorded the regeneration of the vegetation under conditions involving the exclusion of livestock.

Investigations by the Waite Institute will be carried out at additional centres, selected to represent the more important grazing areas of shrub-steppe, with particular reference to the controlled modification of the grazing factor. It is proposed also to study the major ecological relationships between the flora and its environment.

THE ONTARIO AGRICULTURAL AND EXPERIMENTAL UNION

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The idea of an Ontario Agricultural and Experimental Union was first conceived about sixty years ago. At that time it was thought that considerable good might result from the formation of some sort of union where matters pertaining to agriculture might be discussed and the results of experience interchanged. In the spring of 1880 the first regular annual meeting of what was termed the Ontario Agricultural and Experimental Union was held at which officers were elected and a constitution adopted.

The objects of the Union as specified at that time were : " To form a bond of union among the officers and students past and present of the Ontario Agricultural College and Experimental Farm, to promote their intercourse with a view to mutual information, to discuss subjects bearing on the wide field of agriculture with its allied sciences and arts, to hear papers and addresses delivered by competent parties, and to meet at least once annually for this purpose."

Fifty years later a modified draft of the constitution contains essentially the same objective with the following additions : " To conduct experiments in the field of agriculture by united and individual effort, to secure the co-operation of the agriculturists of the Province of Ontario in this work, and to meet at least once annually to hear papers and addresses delivered by competent parties and to report upon the labours of the past year."

The original membership was confined to all officers and students who were or had been associated with the Ontario Agricultural College and Experimental Farm. The annual membership fee was at that time and has continued to be fifty cents a year. The officers elected and the remaining part of the constitution were in accord with the usual practice for organizations of the same general nature.

Early in the history of the organization it was realized that united effort was necessary if the agricultural difficulties were to be met in any adequate way. As early as 1890 the following statement appears in an annual report : " No single experiment station can determine for all localities the best agricultural practices. Each district should aid in securing such information for itself."

In recent years all of the information available in connection with the soil and climatic surveys has been brought together, maps have been prepared which outline the various areas of the Province of Ontario which have approximately similar growing conditions for general cropping purposes. These special divisions have been termed soil-climatic zones and have been made the basis for the distribution of co-operative tests.

Four distinct types of co-operative tests were undertaken. The first was a small observational plot where several of the best varieties have been widely distributed

for comparative tests with the grower's own variety. Much information has been obtained concerning the opinions of the growers as to the general suitability of varieties for widely scattered districts.

A second type of plot was used in instances where there was a demand for a larger area of the various varieties which could be planted with the regular farm machinery. While this type of plot and the smaller observational type are not particularly satisfactory for the securing of accurate yield data they do furnish considerable information relative to the general suitability of the variety in comparison with the grower's own material.

A third type of test plot also of large enough dimensions to be planted by field machinery is being used. In these plots quadruplicate plantings are followed and half of every plot is fertilized with an artificial fertilizer the composition of which is determined by adequate soil tests of the experimental area. A reasonably good idea of the relative yielding capacity of the different varieties is obtained from such plots. Information concerning the reaction of individual varieties to a specific fertilizer is also available from the same material. In many instances these replicated, larger plots are used as centers for holding field meetings during the growing season.

A fourth type of test which has been considerably increased is one in which a large number of the more promising newer varieties are tested in a small, well-replicated planting system. Quite a large number of such plots are being carried on in co-operation with the students of the Ontario Agricultural College, who are specializing in crop work. A still larger number of plots are being laid out on what is termed a semi-permanent crop testing basis. Units of approximately twenty tests are located as being representative of as many soil-climatic zones as possible, and are under the supervision of one person. Such plots are intended to be continued through a period of at least five years on each test area selected, and an endeavour is being made to obtain as much meteorological information as possible in connection with each test.

The last mentioned type of test lends itself very satisfactorily to the securing of fairly exact information concerning the yielding ability of the newer varieties in many of the soil-climatic zones of the Province of Ontario. Accurate seasonal notes are kept of the smaller replicated plot tests and all the information secured is of a nature to lend itself to statistical analysis.

The principal activities of the Ontario Agricultural and Experimental Union throughout the years have been in connection with the co-operative testing of various farm crops. However, from time to time many other types of experiments have been included, such as weed eradication, soil improvement, agricultural co-operation, poultry management, livestock management, reforestation and other special agricultural activities.

The annual meetings have developed into very useful provincial gatherings. In addition to the presentation of the results of the co-operative experiments conducted throughout any year, an attempt is made to feature some different phase of agriculture at each annual meeting. For example, two years ago "Animal Nutrition"

was made the theme of the special meetings. Last year "Plant Nutrition" received special attention, and for the next annual meeting it is planned to feature "Agricultural Co-operation and Marketing."

The whole scheme of an Agricultural and Experimental Union has worked out in a rather interesting manner in the Province of Ontario, and appears to be a type of activity which lends itself to the securing and dissemination of much useful information.

GRASSLAND FARMING IN NEW ZEALAND*

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NEW ZEALAND is essentially a pastoral country ; of the 43,000,000 acres in occupation, 31,250,000 are in pasture, comprising 14,000,000 acres of native tussock grassland and 17,000,000 acres of sown pasture land. Only one and a third million acres are used for the production of annual crops, half the acreage of which consists of cereals and half of annual grass supplementary crops. On this land are grazed 4,500,000 cattle, including 2,000,000 million dairy cows, and 29,000,000 sheep, including 17,750,000 breeding-ewes ; and from these come New Zealand's exports of dairy produce, frozen meat and wool.

When the early settlers arrived in New Zealand they found no open meadow lands such as they were accustomed to in the British Isles. Most of the North Island and the western and southern parts of the South Island were covered in forest. On the low-rainfall areas on the east of the main divide in the South Island and on the light soils of the Central Plateau of the North Island were extensive areas of natural tussock grassland, which were early cut up into extensive grazing-runs for sheep. The mountain tussock grassland of the South Island, covering an area of 13,000,000 acres, still constitutes one of the most important of our grassland areas, and is used for the grazing of Merino and half-bred sheep. The native tussock grasslands evolved in the absence of grazing animals, and with the exception of blue grass (*Agropyron scabrum*) none of the tussocks is palatable to sheep ; the grazier soon found, however, that the fresh growth following the burning of the tussocks was readily eaten by sheep, and this led to the regular burning of the tussock grasslands. Indiscriminate burning, overstocking, and destruction caused by rabbits have led to serious deterioration, and in places to actual depletion of all vegetation on the mountain tussock grasslands. Besides the native tussocks, these grasslands contain numerous other indigenous and introduced plants, and it is to such introduced plants as Yorkshire fog, catsear, and sorrel that the grasslands owe much of their carrying capacity. The improvement and regeneration of our native tussock grasslands are still two of our major problems ; partly economic ones, for fencing and spelling are necessary for the rejuvenation of the native tussocks and introduced pasture plants, but requiring also the collection from other countries of plants suitable for mountain soil and grazing conditions.

Sown pasture land occupies 17,000,000 acres, of which some 11,000,000 acres consist of surface-sown pastures following forest and scrub fires, and 6,000,000 acres

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of pasture sown on ploughed land. A very large part of New Zealand was originally covered with forest, but in pre-European days forest fires had destroyed large areas, and by 1840 approximately 36 per cent of the original forest covering had been converted into open fern plains and hills. With the coming of white colonists forest destruction received a fresh impetus; the forests had to go, for the very existence of the North Island settler depended upon replacing them by pasture. The area sown reached 3,500,000 acres in the late eighties, 6,500,000 acres in 1900, and 11,000,000 acres at the present time; and now we have realized that the destruction of our forests has gone too far, and further areas for grassing must be sought in our ploughable scrub lands. From the time of sowing to the present, the surface-sown pastures have gradually deteriorated; originally sown in ryegrass, cocksfoot, and clovers, large areas have changed to *Danthonia* and *Agrostis*, while other areas have deteriorated to fern and second growth, particularly on the wet elevated areas of the west coast of the North Island. The surface-sown grassland is mainly used for grazing of Romney sheep and beef cattle, and supplies the breeding-ewes for the production of fat lambs on the intensively farmed grassland of the plains. The improvement of hill country pastures is imperative if fat-lamb raising is to increase on the intensively farmed grassland areas. Improvement can be effected by top-dressing and the introduction of legumes—white clover in the wetter districts, subterranean clover in the drier—and a period of high wool and meat prices is quite likely to lead to some development in this direction.

Ploughed grassland occupies an area of 6,000,000 acres. Short-rotation pastures are found in the cereal-growing districts of the South Island, situated on the coastal plains on the east of the main divide. The pastures are composed mainly of ryegrass and are taken in rotation with cereals and fodder crops. Apart from grain and seed growing, the main industry in the arable farming districts is the production of lamb and mutton, and short-rotation pastures are used for grazing breeding-ewes. Owing to climatic conditions, short-rotation pastures provide little summer, autumn or winter feed, and large areas of turnips and rape have to be provided for sheep-feeding in the summer, autumn and winter. Production and permanence of the rotation pastures depend largely on the combination of clover with the grass; over large areas conditions are too dry for the permanence of white clover, and attention is now being paid to the utilization of subterranean clover on the lighter and drier soils.

Permanent pastures are general in the humid parts of New Zealand, and the main feature of grassland development during the past fifteen years has been the progressive improvement of the carrying capacity of permanent pastures on ploughed land in the humid districts. Our pastoral farming started with the occupation of the native tussock grassland, developed through the rapid establishment of surface-sown pastures after cutting and burning the forests, and is now definitely progressing with improved methods of establishing and farming pastures on ploughed land.

The permanent pastures in our humid districts produce the bulk of our dairy produce and fat stock, and while the area farmed has remained fairly constant

during the past ten years, improved carrying capacity has enabled the pastures to graze an additional 1,000,000 head of cattle, including 750,000 dairy cows, and 4,000,000 breeding ewes. This development has been due to the practice of top-dressing, the selection and adoption of improved strains of grasses and clovers, and the adoption of improved grassland management methods.

About 2,500,000 acres of grassland are annually top-dressed, about half the area receiving phosphates alone and half phosphates and lime, and certain areas potash in addition, while occasionally nitrogenous fertilizers are applied for special winter feed provision. The practice of top-dressing started in the eighties on the light soils of the Middle Waikato Basin in South Auckland. Much of the early top-dressing was done with a mixture of superphosphate, bone-dust and rock phosphate, and the practice enabled short- and long-rotation pastures to be turned into permanent ones. The first cargo of basic slag arrived in New Zealand in 1892, and the fertilizer soon proved its value as a rejuvenator of old pastures. By 1900 top-dressing was becoming a recognized practice in the Waikato, South Auckland and Taranaki Districts. Basic slag was extensively used and importations of slag rose from 4,000 tons in 1909 to 30,000 tons in 1914. During the war, top-dressing was still largely practised, but as the war progressed fertilizer importations gradually decreased and supplies of slag were cut off. It was during the war that superphosphate became increasingly popular as a top-dressing fertilizer, and this is at present the chief phosphate used, although slag is also largely used in certain districts.

Top-dressing is often the largest single item in a farmer's working costs, and the Fields Division of the Department of Agriculture has conducted a considerable amount of research work on the phosphate, lime and potash requirements of the main top-dressed areas. The chief work undertaken has been with simple observational experimental plots, and although these plot responses are not above criticism, they do show the main deficiencies; their chief weakness lies in not showing the benefit obtained from stock manure. In top-dressing plot work, white clover is the index plant. Normally if phosphates alone give a good white-clover growth, phosphates alone are required; some soils require lime in addition to phosphates, and on other soils potash is required in addition to enable white clover to grow vigorously. Gradually these observational plots are being linked up with the soil surveys conducted by the Department of Scientific and Industrial Research, and in the Auckland Province, where most of this work has been done, a study of the soil profiles and fertilizer response surveys suggests that reasonably accurate fertilizer requirements for each main soil type will be worked out from the simple observational plots. For instance, with the podsols and podsolized soils, the need for lime becomes more evident as the profile becomes more mature and only the skeletal and slightly podsolized soils give a good response to superphosphate alone. As the soil survey and observational experiments develop, further work is being done with alternate mowing and grazing experiments in an endeavour to measure the extent of the responses.

Top-dressing means more grass, and grass with a higher peak of production; and this necessitates better farming methods. The first move in the better utiliza-

tion of the extra grass has been in the wider use of breeding animals—the dairy cow and the ewe—and secondly in the substitution of hay and grass silage for annual crops for supplementary feeding. Progress in top-dressing and utilization is by no means uniform even on farms in the same district; the scope for development is such that even in highly-farmed dairying districts great increases in carrying capacity may be looked for in the future. Many dairying districts will have an average butterfat production of 100 to 150 lb. per acre, with individual farms producing 200 to 250 lb. of fat per acre, and it is interesting to consider how the increased production from 100 to 200 lb. per acre is obtained. It is really the application of the old principles of more stock, more manure and better crops; and the start of the upward climb in production is heavy top-dressing to give increased grass growth, accompanied by increased stocking to utilize the grass and return manure to the soil.

Coincident with the development of top-dressing and better management methods has been the introduction of improved strains of grasses and clovers—notably perennial ryegrass and white clover. The selection of the truly perennial strains of ryegrass and the certification of the seed have been two of the most important recent events of our grassland progress. In addition there has occurred the selection of leafy strains of cocksfoot, stronger growing and permanent white clovers and the use of Montgomery red clover in place of broad red in permanent pastures. The improvement in our pasture plants and management methods has been reflected in some changes in our grass seeds mixtures. More and more reliance is being placed on perennial ryegrass and white clover in permanent pastures in humid districts for, with adequate rainfall and the ability to make up soil deficiencies with top-dressing, there has developed a tendency towards standard mixtures. For dairying land the standard mixture (in lb. per acre) would be somewhat on the following lines: perennial ryegrass 25; cocksfoot 8-10; timothy 2; crested dogstail 2; red clover 2; and white clover 2. Italian ryegrass up to 5 lb. might be sown in addition to or in place of part of the perennial ryegrass. The aim in grazing and management is to develop the ryegrass—white clover pasture. There is a difference of opinion as to the part cocksfoot (and also timothy and dogstail) should play in the pasture. There are advocates of special pastures for special feed periods—i.e., pastures of Italian ryegrass for winter and spring, cocksfoot and red clover for summer and autumn, prairie grass for winter feeding; but the special pasture, with some exceptions, is not adopted in farm practice. Paspalum, and pastures of paspalum, ryegrass and white clover give summer feed in the northern parts of the Auckland District. Italian ryegrass is not used to any extent outside the arable farming districts. Special fields of prairie-grass are confined to naturally rich land, and on other land are not likely to be adopted until a suitable companion clover is obtained. The place of cocksfoot and perennial ryegrass is regulated by management; on the fields that are regularly grazed perennial ryegrass becomes dominant; on fields frequently closed for hay and silage, cocksfoot becomes an important plant in the turf.

The extension of our grasslands is now being made by the conversion of plough-

able scrub land into pasture, and most of the undeveloped scrub land is situated in the Auckland Province. The two important areas are the pumice lands of the Central Plateau and the gum lands of North Auckland—both comprising soils of low natural fertility and yet capable of being successfully developed into high-class pasture land. Their development illustrates the importance of legumes in pasture establishment, and present methods of grassing favour the initial establishment of permanent pastures with heavy top-dressing rather than the primary building up of fertility through special soil-improving crops.

The pumice lands of the Central Plateau are light soils formed from volcanic-ash showers, and in their natural state are covered in low manuka and manoao scrub, with open spaces in tussock. The soils are deficient in phosphates and nitrogen, but, with the exception of certain areas of coarse sand, hold moisture well. Early grassing was accomplished by first sowing, after ploughing, temporary pastures of Italian ryegrass and red clover; and with phosphatic manuring, and consequent luxuriant red clover growth, the soil fertility was improved and the land was later sown down in permanent grass. The present tendency is to sow permanent pastures consisting of perennial ryegrass, cocksfoot, red and white clover after the first ploughing, and to top-dress the pasture heavily with superphosphate, the land receiving 3 cwt. at sowing down, 3 cwt. three to four months after sowing, and thereafter 3 cwt. per annum. This heavy phosphating gives a strong white clover growth, which in turn encourages a strong perennial ryegrass growth, and high class ryegrass—white clover pastures may be obtained twelve months after breaking up the land—land that in its natural state would appear incapable of carrying high-class milk-producing pastures.

The gum-land soils occur in patches throughout North Auckland; the areas consist of low undulating treeless downs rising occasionally into low hills. The soils are grey silts (mature podsols); drainage is bad, and rushes and manuka scrub cover the areas. Early developmental experiments aimed at first raising the soil fertility by ploughing in green crops, the use of burnt lime, subsoiling and tile drainage —a very expensive programme. The next stage was the use of *Lotus hispidus* in temporary pastures to raise soil fertility before permanent grassing. Then came certified perennial ryegrass and white clover, careful cultivation, the use of phosphates and ground limestone, and now excellent permanent pastures can be established after the primary cultivation. The essentials of the method are the successful establishment of white clover and the maintenance of its vigour with adequate supplies of phosphates and lime. In breaking in this land the surface covering is first cut and burnt; holes are filled up, and the land is ploughed in the autumn and winter and allowed to weather in the unbroken furrow slices. It is then harrowed and ploughed again in the late spring, harrowed and worked during the summer and prepared for sowing in grass in February. Thorough and early cultivation with two ploughings gives an excellent seed-bed, the bottom being firm and moist; firmness is essential for white clover establishment. Again white clover growth is stimulated with heavy phosphatic and lime dressings; the land receives a ton of ground lime-

stone before sowing and 3 cwt. of superphosphate or slag at sowing-time, a further 3 cwt. three or four months after sowing, and thereafter 3 cwt. per annum. The keynote to success is thoroughness ; if the seed-bed is not firm or the seed is sown late, white clover does not establish and without white clover the grasses will not grow.

Briefly then, our grassland history has been first the exploitation of our natural grasslands, then the establishment of surface-sown pastures in place of our forests, and latterly the development of artificially cultivated high-producing pastures on our ploughed land. The further development of our grasslands naturally depends on the extent of our external markets. With our present knowledge of grassland management the carrying capacity of our pasture lands may be greatly increased, and very large areas of unoccupied ploughable scrub land turned into high class pasture land.

THE LEGUMES OF GRASSLAND*

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[Translator: G. M. Roseveare]

An attempt should be made to free the mind of the usual conception of grassland as a well defined type of crop, somewhat of the rank of a cereal crop; of the conception of an accumulation of plants in which, in addition to the more well-known grasses and clovers, a series of weeds makes its appearance as a troublesome by-product. Grassland should be regarded rather as a plant group having a very great degree of elasticity, a group—in Germany, as in other countries—found within far wider boundaries of soil and climate than arable land and forest together. Not only are steppe, fen, heathland and halophyte association present, but they are all—generally or in isolated cases—used and valued as range, rough grazing, pasture or meadow. And this manysidedness of locality and plant association corresponds to a similar manysidedness in the grassland legumes. Each species appears to be so independent within its own area of distribution that it seems useless to attempt any common treatment of them. In one thing alone do they correspond to one another, namely, in the peculiarity of the symbiosis with bacteria elucidated by Hellriegel, and therewith naturally in everything directly related to this character.

In other respects distinctions must be made. (See tables on pp. 168 and 169.)

In making several thousand analyses of grassland we found that, per hundred areas, 90 to 95 per cent contained *Trifolium pratense* and *T. repens*, and that 60 to 75 per cent contained *Lathyrus pratensis*, *Lotus corniculatus* and *Vicia sepium*. On the other hand only 10 to 20 per cent contained *Medicago falcata*, *M. varia*, *Lathyrus montanus*, *Lotus uliginosus*, *Anthyllis vulneraria*; and only 1 to 3 per cent *Trifolium fragiferum*, *T. spadiceum*, *T. medium*, *Melilotus dentatus*, *Lotus tenuifolius*, *Tetragonolobus siliquosus*, *Lathyrus paluster*, *Genista* spp., *Onobrychis viciifolia*. These are figures which indicate that there is a clear contrast here between universalists and specialists.

The distribution of the two principal clover species, *Trifolium pratense* and *T. repens*, is as a matter of fact astonishing. For them in consequence no localities can be clearly defined as optimal in regard to growth factors. These species are at home in soils poor and rich, very acid and alkaline, dry and moist, and only in extremely acid, alkaline and wet soils or under the action of heavy applications of nitrogenous fertilizers do their frequency and vitality decrease to any marked extent. The two species appear to be particularly adaptable; but this is only on account of their very great degree of polymorphism. The individual plant and its descendants are not more adaptable than the specialists. The latter are for the most part poor in forms,

*Translation of an article published in German in *Forschungsdienst*. Suppl. 6. 226-32. 1937.

and in general it may be said that the degree of adaptability corresponds approximately to the number of morphologically distinguishable forms, which undoubtedly represent a still greater number of physiological races. We have here a grave warning against any kind of formalism in the breeding of herbage plants.

If we turn our attention to the "non-adaptable" specialists, the matter appears to be most simple in the case of the group

Lotus tenuifolius
Trifolium fragiferum
Tetragonolobus siliquosus
Melilotus dentatus.

These represent a series of increasingly salt-tolerant species; at the beginning of the series sodium chloride may be substituted by nitrates or carbonates, that is to say by salts generally. But here also matters only appear to be simple; in actual practice there are still many open questions in the halophyte problem. That these species find their optimum in the alkaline reaction sphere is almost a matter of course.

This tendency to prefer neutral to alkaline reaction is shared, it is true, by many grassland legumes, but certainly not by all. Many species are to a large extent indifferent in their behaviour, red clover and white clover in particular, and also *Trifolium minus*, *Lotus*, *Vicia cracca* and *T. hybridum.*

With increasing distinctness preference for alkaline reaction is exhibited by the species

Trifolium procumbens
Medicago lupulina
Medicago falcata and *M. varia*
Onobrychis viciifolia.

In sharp contradistinction is the very marked preference for acid to extremely acid reaction in the species

Lotus uliginosus
Trifolium medium
Trifolium spadiceum
Lathyrus montanus.

Is it actually soil reaction which is the decisive factor in determining locality for these species? No, for here also things are much more complicated. Each of these species is a unit in itself, having special requirements not only in regard to locality in the broadest sense of the word, but also in regard to its adjustment in the local plant association.

Medicago and *Onobrychis viciifolia* require to be in light plant stands in warm, permeable, dry soils; these three conditions are most easily obtained in neutral to alkaline soils with an abundance of calcium. *Lotus uliginosus* prefers at the same time abundant supplies of humus and water and yet a certain amount of mineral substance in loose soils. A combination of these conditions, again, is found practically nowhere except in slightly to markedly acid moor and marsh soils. A considerably stronger preference for crude humus is exhibited by *Trifolium spadiceum*

and *Lathyrus montanus*, the former more in moist situations, the latter rather in dry places. Common to both is the preference for high, rainy localities and those grasslands which are situated in coniferous woodland, *Calluna* or *Nardus* heathland, and therewith preference for extremely acid soils.

Lathyrus paluster, finally, exhibits very narrowly defined requirements in regard to locality. It demands an abundance of water; but the water may not entirely stagnate, nor may the summer water-table vary too much or too frequently; it avoids, therefore, definite swamps just as much as localities with frequent summer flooding and those in which there is much sinking of the ground water. In addition to this, it avoids the competition of close swards and seeks preferably loose, tall stands of rushes, reeds and top grasses. In contrast to the universal *Trifolium pratense*, which is at home in any locality and in almost every plant association and was therefore easy to take into cultivation, there is seen in *Lathyrus paluster* a species strictly confined within narrow limits of locality and association, a species which it is practically impossible to cultivate deliberately or even to encourage to any marked extent.

Sometimes the influence of the plant association is just as great as that of the locality. Legumes with their relatively slow development and their heavy requirements of light shun all close and tall swards, especially that of *Alopecurus pratensis* where the latter is typically developed. The same holds good for all top grass stands heavily manured with nitrogenous substances and for new sowings consisting preponderantly of vigorous grasses.

Of other plant associations avoided by legumes there should be mentioned the pure *Nardus stricta* heaths on extremely acid crude humus, inimical to bacteria; and on the other hand tall sedge stands with stagnant moisture and mud soil.

Contrariwise there is seen as a rule an increasing participation of legumes in the sward as moisture diminishes, soil mineral content increases, and the ratio of sward components of low or loose growth increases. Similar conditions are encouraging, however, for many weeds, and thus increasing ratios of legumes and weeds nearly always go together. The highly productive meadow composed entirely of grasses and clovers that frequently haunts our literature is Utopian, and unthinkable under the pressure of competitive development. Grazing alone will produce anything approaching this desirable state of affairs.

So much for the general and natural aspect of the question. What are the possibilities of interference on the part of man? They are very great, and are all the greater, the poorer the initial plant stand.

In the *Nardus stricta* heathlands which have arisen in nearly all our hill country through centuries of ruthless exploitation, in these podsolized, acid crude humus localities a superficial glance detects no legumes. And yet they are present, either in stunted form or in dormant seeds. A minimum supply of mineral or nutrient substance—builders' rubbish, mud from the road, farmyard manure, hotel refuse—is often sufficient to conjure up in positively explosive fashion two, four, or even ten species of legumes. Here they are definite pioneers, which initiate and help to complete a suppression of the heath flora if—*if* the supply of nutrients is continued.

Otherwise reversion to heath sets in again very rapidly—the fate of many a hopefully begun hill improvement scheme—for at the outset the enriched, somewhat neutralized soil layer facilitating the growth of legumes forms only a thin cover over the unchanged crude humus soil.

Equally astonishing often is the success of applying farmyard manure to legume-deficient grassland when mature hay of high legume content from other areas has been fed to stock. A large proportion of the legume seed traverses the alimentary canal of cattle apparently uninjured. The secret of abundant clover growth in regions rich in grassland and cattle as compared with regions with a very wide grassland ratio is based largely upon these circumstances ; here, at all events, as in the foregoing example, there is to be seen a very great clover-encouraging action on the part of nitrogenous fertilizers also, produced by indirect influences (soil fertilization or seed introduction). In average meadows the course is generally otherwise. By "average" I understand the two-cut meadow of the type most generally seen in Germany, giving a yield of approximately 40 dz. hay per hectare and composed on an average of

50 to 60 per cent grasses,
10 to 15 per cent legumes,
35 to 40 per cent other plants (" weeds").

This grass : clover : weed ratio, which varies little over wide areas, represents an equilibrium wherein no plant group finds optimal conditions, least of all the grasses, which are more dependent upon the fugitive element " nitrogen " than are the clovers and miscellaneous herbs.

When such meadows are dressed for a considerable time with Ca, P and K, a considerable increase in the proportion of legumes generally occurs. In accordance with the nutritive supplies of the soil, now P, now K, and now Ca is decisive, or even a supply of mineral substances alone (sand, builders' rubbish, etc.), although P generally produces the greatest effects. It is not necessary to go into the principles governing this phenomenon.

Not seldom the encouragement of the clover species goes so far that marked deterioration with all the symptoms of soil sickness ensues, or the moisture-loving legume species are burnt out over large areas in a year of drought. In either case the gaps which arise are filled out not by grasses alone, as one would wish, but generally to a large extent by all manner of weeds. It is never good to carry a practice to excess.

As a general rule, however, because of the slow interchange of position between all meadow plants there are no signs of soil sickness. It is not as if the individual grass, clover, or weed plant occupied the same spot in the sward decade after decade, for seeding, tiller formation, and continuous one-sided or radiating tuft formation produce a continuous change of position, that is to say a peculiar type of rotation.

The direction of this alteration in stand, and above all the manner in which the non-nitrogenous fertilizers act, result in meadow yield rising evenly to a certain maximum point and, when the use of PK is continued afterwards, in the maintenance of this maximum — apart from seasonal fluctuations. The reliability of the result of

Table 1.—Distribution of some legume species in areas of varying degrees of moisture.

	Dry	Medium moist	Moist	Wet
Anthyllis vulneraria	**100**	5	—	—
Onobrychis viciifolia	**100**	36	—	—
Medicago falcata/varia	**100**	75	9	—
Trifolium repens	89	**100**	92	72
Trifolium pratense	93	**100**	92	93
Lathyrus pratensis	68	**100**	**100**	85
Trifolium hybridum	41	65	84	**100**
Lotus uliginosus	8	27	53	**100**
Trifolium fragiferum	—	28	60	**100**

Table 2.—Constancy of some legume species.

	General	Upland meadows	Lowland meadows
Trifolium medium	4	**100**	2
Lathyrus montanus	15	**100**	5
Trifolium spadiceum	3	**100**	7
Vicia cracca	54	**100**	90
Trifolium pratense	95	97	**100**
Trifolium repens	90	80	**100**
Lathyrus pratensis	75	49	**100**
Medicago falcata/varia	18	—	**100**
Lathyrus paluster	2	—	**100**

Table 3.—Distribution of some legume species in areas of varying soil reaction.

	pH 3.4 to 4.4	4.4 to 5.4	5.5 to 6.6	6.7 to 7.2	7.3 to 8.5
Lathyrus montanus	**100**	31	14	4	4
Lotus uliginosus	**100**	90	66	31	21
Trifolium spadiceum	57	**100**	29	—	—
Vicia cracca	93	**100**	95	77	73
Trifolium repens	91	99	**100**	94	97
Trifolium hybridum	64	85	98	**100**	98
Medicago lupulina	12	34	66	83	**100**
Medicago falcata/varia	2	9	3	34	**100**
Onobrychis viciifolia	—	9	9	45	**100**

Table 4.—Distribution of some legume species in areas with different supplies of P, K, Ca.

	Deficient	Medium	Good supplies
Trifolium medium	**100**	67	11
Lathyrus montanus	**100**	33	11
Lotus uliginosus	**100**	47	33
Trifolium repens	94	**100**	96
Lathyrus pratensis	96	**100**	93
Trifolium pratense	98	**100**	99
Trifolium hybridum	73	76	**100**
Medicago falcata	48	57	**100**
Onobrychis viciifolia	—	12	**100**

Table 5.—Proportion of legumes in different plant associations (examples from Stebler).

Meadow type	Percentage proportion of grasses	legumes	other species
Nardetum	46.8	—	53.2
Nardetum	57.6	2.0	40.2
Caricetum gracilis	2.2	—	97.8
Caricetum distichae	14.5	—	85.5
Brometum on lime sand	63.8	1.5	34.7
Molinietum	44.3	4.1	51.6
Agrostidetum	63.6	17.6	18.8
Arrhenatheretum	43.4	18.6	38.0
Brometum, manured	28.7	20.5	50.8
Arrhenatheretum, clover subtype	49.4	37.3	13.3
Brometum, clover subtype	25.2	42.1	32.7

PK in meadows is probably greater than that of any other form of manurial treatment on arable and grass land.

Its weakness lies in the fact that it produces neither the highest yield obtainable nor hay free of weeds, while on the other hand there is no doubt that it produces the fodder most rich in protein and mineral substances.

If, however, one of these average meadows is given heavy applications of nitrogenous fertilizers, a great suppression of clovers generally sets in. This is in part explained by the less ready translocation of water in the clover species in comparison with the grasses, but in my opinion it is preponderantly the consequence of a deficiency of light and of similar competitive factors having a more physical action. Together with the clover species many slow and low-growing weed species are also suppressed. In the grass part of the stand two different processes generally follow with rapidity one upon the other; first of all a great closing up of the sward, and then an ever greater increase in the appearance of tall, stemmy top grasses. These then increas-

ingly oust the fine-leaved bottom grasses, the clover species and the less aggressive weeds; the sward grows more and more bare, and there arise very labile, unnatural accumulations of plants; labile because

(1) a continuous excess of N, especially in the form of farmyard manures, leads to the suppression of even the most aggressive top grasses by the so-called "ammonia weeds";

(2) cessation to apply further N generally leads to a heavy decrease in yield and to weed growth. The top grasses produced by heavy applications of N fail, but the clover species and bottom grasses, which otherwise might have filled up the gaps, have been reduced to mere traces. The gaps are colonized by fast-growing weeds.

The suppression of clovers is the main reason why the heavy application of nitrogenous fertilizers to meadows, after producing maximum yields for a time, generally exhibits rapidly-diminishing efficacy, and why long duration experiments have nearly always led to the abandonment of nitrogenous fertilizers in the case of meadows. In any case the high yields obtained from full manuring can only be used up at long intervals, and then only if one reorganizes for fundamentally different forms of utilization.

These consist in frequent cutting or in grazing. With uniform manurial treatment, even with heavy doses of N, the proportion of clover increases almost parallel with the frequency of cutting, or even more rapidly. Certainly the amount of labour entailed and the drop in yield increase at the same time.

The ideal solution of the problem—how to maintain the clover in spite of the continuous effect of N—is grazing, provided the sward is kept continually short enough. The loss in yield entailed through frequent cutting is eliminated thereby, as the assimilating leaf surface is not entirely removed, but always in part only. The fact of the existence of a large proportion of clover even in many pastures which receive heavy applications of N, of diluted or undiluted liquid manure, indicates clearly that it is in the main deficiency of light and not a direct action of N that leads to the suppression of clover in tall stands.

With these few examples we will leave the subject of the effect of management upon grassland legumes—although this group of plants reacts clearly to many other forms of interference also—and attempt to outline briefly the part played by the legumes.

(1) On the poorest grassland areas the legumes, here often present in traces only, form not only indicators, but also the source of the first results of improvement without ploughing up.

(2) In average grassland the clover species represent the foundation of and the reserves for the very reliable effects and after-effects of PK. Only their entire lack suggests that the application of N is immediately necessary.

(3) Of especial importance are the legumes as a source of fodder improvement. An increase of 5 to 20 per cent in the proportion of clover, such as can generally be obtained by systematic application of PK, means apart from increase in yield a very considerable increase in the protein and mineral content of the fodder.

(4) The legumes form an important factor in equalizing the seasonal, annual and periodical fluctuations in grass growth, both as regards quantity and especially quality.

(5) On the other hand, the direct supplying of valuable grasses with nodule nitrogen in average or even in highly productive meadows must not be overestimated. Actual circumstances to a large extent conflict with this assumption, for

(a) the meadows with the highest proportion of clover are generally also rich in weeds, poor in grasses and never the most highly productive ;

(b) the meadows which have great bulk yield and are poorest in weeds are generally poor in clovers.

It is, however, possible to obtain mixtures having a satisfactory proportion of one species to another, especially in regard to the nutritive value of the hay crop. The most important measures (with the exception, of course, of soil improvement) are :

(a) adequate, or better, very abundant supplies of P, K, and Ca ;

(b) more early and more frequent utilization together with increasing supplies of N, carried as far as utilization of the same area for hay and grazing, and utilization as permanent pasture ;

(c) soil consolidation, where necessary, and the avoidance of deep scratching ;

(d) curing the specially endangered clover-rich hay without loss.

It is impossible to think of the life of grassland without the legumes, they are a natural part of all true swards. But their proportion in the sward can neither be kept quite stable nor can it be increased to an unlimited extent. The boundaries against which we come here are the laws of the plant association, which may certainly be modified by human agency, but cannot be entirely set aside. An observation of them will always be the key to successful grassland management on a natural basis.

REVIEWS

VARIATION WITHIN STRAINS IN NORWEGIAN RED CLOVER

[Reviewer : R. PETER JONES]

LEAFINESS

Wild red clover is considerably less leafy than cultivated clover and is, therefore, a much poorer fodder plant (Table 6). In late red clover there is marked variation in the degree of leafiness. As a result of selection for this character families have

Table 6. Leafiness in cultivated and wild Norwegian red clover.

Strain	Number of plants with degree of leafiness				Total number of plants
	Large	Medium	Small	Very small	
Cultivated clover					
Molstad	12	106	115	2	235
Toten	—	35	38	—	73
Leinum	2	20	21	—	43
Fosnes	3	17	8	—	28
Hove		2	7	—	9
Total cultivated clover ..	17	180	189	2	388
Per cent	4.37	46.41	48.71	0.52	100.01
Bråtå	8	38	62	6	114
Per cent	7.02	33.33	54.39	5.26	100.—
Wild Clover					
Foss			26	1	27
Løken	6	20	78	2	106
Etnestølen		9	93	22	124
Sikkilsdal	6	30	86	9	131
Røros		2	45	1	48
Inderøi	2	11	39	4	56
Vidarshov.		8	28		36
Total wild clover	14	80	395	39	528
Per cent	2.65	15.15	74.81	7.39	100.—

Undersøkelser over norsk rødkløver. Variasjonen innenfor stammene. [Investigations on Norwegian red clover. Variation within strains.] *Tidsskr. norske Landbr.* 44. 161-83. 1937.

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been produced with 8 per cent more leaves than Molstad (Table 7 in original text). Increased leafiness is of great importance in breeding work where improvement in the quality of clover hay is concerned.

Chemical content

As the leaves contain approximately twice as much protein as the stems, an increase in the percentage of leaf should automatically result in an increase in protein content. In the summer of 1936 some chemical analyses were carried out of families which had been investigated for leafiness. The results are given in Table 8 in original text. Molstad has 13.86 per cent crude protein, the best family has 1.68 per cent more, the poorest 0.95 per cent less. An increase in protein percentage of 1.68 per cent means an increase in protein production of 12.12 per cent.

The increase in the protein content is closely connected with the increase in leafiness. Family XVIII with +1.68 per cent in crude protein has +8.79 per cent in percentage of leaf.

Hardiness and persistency

These two characters are, under Norwegian conditions, the most important of all. Persistency of clover plants depends to a great extent on hardiness, but it is also conditioned by other characters such as resistance to disease, and probably also by specific physiological properties of longevity.

In the strain trials the majority of the clover plants lived for two years ; in the third year they died or were very weak ; the third year ley gave only approximately 10 per cent of the total clover yield obtained from the ley throughout. Table 9 contains data on persistency of single plants of Molstad and some families selected from that variety. On the average for Molstad and all the families it is seen that with

Table 9. Persistency of clover plants.

Percentage of plants with age	YEAR 1st	2nd	3rd	4th	Total number of plants
Molstad 1921-25	100	100	26.4	8.4	87
1922-26	100	100	?	9.6	104
Families selected from Molstad Field					
A 1926-30	20.4	20.3	16.0	11.1	1509
B 1926-30	?	25.7	20.0	15.1	1236
C 1928-32	100	100	60.8	few	620
D 1928-32	81	61.5	30.2	few	486
E 1929-33	95.5	85	55.9	0.9	354
F 1929-33	97.8	81	13.3	few	955
	85	71.7	31.8	5.6	5351

a total number of 5,351 plants, 85.5 per cent were alive after the first year, 71.7 per cent after the second year, 31.8 per cent after the third year and 5.6 per cent after the fourth year. A few plants survived into the fifth year. Thus approximately one-third of the plants remained to furnish the third year's yield.

Data on persistency in some material of cultivated and wild clover (presented in Table 10 of original text) show the number of plants alive at the different dates when counts were made. The winters during the period of the trial were mild. It is the third year in particular which is critical for clover and the largest number of plants generally die then ; in the cultivated clover planted in 1932, however, many plants died in the course of the summer of 1934. Persistency depends therefore not only on the winter ; development and mortality in the course of the growing period must also be studied.

Wild clover has not proved more persistent than cultivated.

It has been found that the productivity of individual plants diminishes with an increase in their age. Table 11 contains data on the productivity of clover plants in the first, second and third year. The weight per plant has decreased markedly from the first to the third year. It is seen from the table that families differ greatly in their ability to maintain productivity. Mosaic disease may possibly be responsible in part for the reduction in vigour in later years.

Table 11. The productivity of plants in the 1st, 2nd and 3rd years.

Family No.	Grm. per plant			
	1931	1932	1933	Mean
1	336	223	140	233
2	290	242	101	211
3	185	161	128	158
4	249	127	78	151
5	242	194	140	192
6	358	178	52	196
7	437	199	142	259
8	399	270	159	276
9	387	108	74	190
10	375	159	135	223
11	281	161	84	175
12	303	164	89	185
Average	320.2	182.3	110.2	204.2
Relative values	100	56.9	34.6	

Time of flowering

In single plants the beginning of flowering was recorded when at least three heads had opened. Norwegian cultivated clover is a late type; in the strain trials there was found to be a certain, but not a great difference in earliness between the strains. Only one cultivated strain, Bråtå clover from Skjåk, stood out from the others, as it was 11 days earlier than Molstad. Both in its earliness and in a series of other characters Bråtå clover occupies an intermediate position between late cultivated and early wild clover. The latter flowers two to three weeks before late clover and Bråtå lies almost midway between them and flowers at about the same time as the F_1 generation of the cross wild $\times$ cultivated clover. It is therefore very probable that it is the product of a cross between them. Table 12 in original text shows data on flowering in single plants of late clover, wild early clover, Bråtå clover and the F_1 generation of the cross wild $\times$ cultivated clover.

The question of the correct time of flowering is closely connected with problems of pollination and seed setting. The author's investigations have shown that even Norwegian late clover is poorly pollinated in the first part of the flowering period when the number of pollinating insects is too small. Humble-bees do not appear in large numbers until the end of July, when the clover has been in flower for two to three weeks. The latest clover will, therefore, be the best pollinated.

Under Norwegian conditions late fertilization is a disadvantage, because seed development and ripening are uncertain. August is often wet, and in September the temperature is low, so ripening proceeds slowly. For practical seed production it is probably best to have strains with a long flowering period.

Length of Corolla Tube

The most important insects for the pollination of red clover are humble bees, but, as recent investigations have shown, honey bees are also important. The effectiveness of the pollination work of honey bees would probably be increased if a clover with a shorter corolla tube were available. It is now thought that a reduction of 2 to 3 mm. in corolla tube length would have significant results.

Table 13 shows variation in length of the corolla tube in Norwegian red clover. Twenty Molstad plants measured in 1933 varied from 8.5 to 10.5 mm., the average length being 9.43 mm. In the same year family 9 - 1 - 1 - 3 varied from 6.5 to 8.5 mm., with an average of 7.67 mm. The author has a series of families which are descendants of plant No. 9 and which throughout have corolla tubes approximately 2 mm. shorter than those of Molstad clover. These families are hardy and vigorous and are now being investigated for hay and seed yield.

Table 13. Variation in corolla length in Norwegian red clover.

	Number of plants with corolla length in mm.										Total number of plants	Mean
	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0		
1933												
Molstad					3	5	5	6	1		20	9.43
9–1–1–3	1	1	3	4	1						10	7.67
1934												
Molstad					1	3	4	4	3	1	16	9.72
A 35–2				1	1	1	4	2	1		10	9.40
A 55–1					2	4	3				9	9.06
9–1–1–1–15			3	2	5	5	1	1			17	8.56
9–1–1–1–11			2	1	5	2					10	9.35
9–1–1–1–12		1	6	1	2	1					11	7.82
1935												
Plants selected for breeding			3	6	10	33	27	26	8	1	114	9.33
A 95–1					2	5	2				9	9.00
1936												
Selected plants			1	6	3	15	21	18	2	1	67	9.39
9–1–3 II–III–IV				8	5	4					17	8.38
C–LIX							1	4	2		7	10.07

Stem Colour

Stem colour in red clover varies from dark red through a series of gradations of red to light green. Connected with stem colour is the colour of the stipules, which varies from dark red to green, but there are also types with green stems and dark red stipules and vice versa. There are doubtless great hereditary variations in this character, and, by inbreeding, families homozygous for different colour types have been produced. But colour, both distribution and intensity, varies greatly according to external conditions.

Flower Colour

Flower colour is even more variable than stem colour. Hitherto the author has distinguished ten colours in Norwegian clover. They vary greatly according to external conditions. When but little daylight is available, they all become lighter and correct classification is impossible. Undoubtedly a series of hereditary factors exist by which flower colour is influenced.

Pubescence

The author has arranged wild and cultivated Norwegian red clover in the five following categories according to pubescence of stem :

1. Hairiness dense, hairs projecting
2. Hairiness fairly dense, hairs not projecting
3. Hairiness sparse, appressed hairs on the greater part of the stem
4. Hairiness sparse, appressed hairs on the upper portions of the stem
5. Completely glabrous.

The results are presented in Table 14 of original text. Only one plant was recorded as glabrous and it is possible that this too had a few hairs. Both in wild and cultivated clover number 4 is the dominant type and must be regarded as the principal type in ordinary "glabrous" clover. But the densely hairy and "projecting hair" types occur both in wild and cultivated clover.

In Norway the preference is for the glabrous type which gives a purer, more palatable hay, and strongly hairy types are rejected during selection.

Leaf Spot

A large number of plants, particularly in wild clover, lack the leaf spot (Table 15 of original text). Cultivated clover has only 9.84 per cent plants without leaf spot and wild clover has 31.72 per cent. Bråtå again occupies an intermediate position with 15.32 per cent plants without leaf spot.

The leaf spot varies greatly in size, form and intensity. It is usually situated in the middle of the leaf in a central position, but may be apical or basal.

Resistance to Disease

Table 16 in original text contains data on mildew (*Erysiphe polygoni*) in Molstad and Toten clover and in some families selected from Molstad. In Molstad and Toten, plants showing all degrees of attack occur. The families cited exhibit great differences both in the number of plants which were attacked and in the severity of the attack. Some families from plant No. 9 are highly resistant.

Peronospora trifoliorum has occurred from time to time without causing serious damage to the stand of clover. In 1929 there was a severe attack, and inbred families showed distinct differences in resistance to the disease.

SOME RECENT ADVANCES IN AGRICULTURE

The Presidium of the Academy of Agricultural Science, Moscow, undertook in 1937 the publication of a special series under the general title of "*Novoe v Seljskom Hozjaĭstve*" (News in Agriculture). Each of the serial issues is to be devoted to a definite item presented by a scientist or a group of scientists in a form readable to laymen. The choice of the problem or the number of scientists working it out is not restricted within narrow limits, but the publishers, apart from other prerequisites, emphasize that the subject chosen for discussion must actually be new and that it must (but again within wide limits) be of practical importance. The series is published by Seljhozgiz, Moscow.

Up to the present the Herbage Bureau has received the first seventeen issues of this series and a brief description of each of the issues is given below. In addition

to text figures, diagrams and, in some cases, coloured plates or figures on separate sheets, a photograph of the author or authors is given as a frontispiece.

Further details of those papers which do not come within the terms of reference of the Herbage Bureau may be obtained from the appropriate Bureau.

1. Re-Building the Nature of Plants,
by T. D. Lysenko, Institute of Plant Breeding and Genetics, Odessa.
(pp. 46, with 10 text figures).

The opening issue was chosen to summarize the results obtained by the author and his associates in research on (1) intravarietal crossing, and (2) alteration of the genotype by means of what has become known as " training " of plants, which is aimed ultimately to direct the evolutionary process in the plant kingdom. Both these research items have a common theoretical basis, namely, the somatic cells are claimed to affect the constitutional formation of the germ cells, while in the formation and constitution of the somatic cells the environment leaves a deep and irreversible impression—conceptions which have been reviewed in *Herb. Rev.* (5. 118-20. 1937) and elsewhere in connexion with the Fourth Session held at the Academy of Agricultural Science, Moscow, in December, 1936. Referring to the results obtained in the study of the first item, Lysenko recommends the substitution of selfing by crossing between plants of the same seed, and by grafting if the plants are endowed with the faculty for vegetative reproduction. Results of experiments on " training " are much more promising ; in particular this method enables breeders to build up winterhardy strains by prolonging the length of the first developmental phase in non-hardy or only slightly hardy basic plants.

2. Artificial Pollination of Maize,
by A. S. Musiǐko, Regional Agrarian Administration, Odessa.
(pp. 15, with 8 text figures).

In its main outlines the method recommended consists in pollinating ripe female florets by shaking the pollen from cut male florets, or by pollen collected from them. This method is primarily intended to prevent the consequences of the discrepancy in time of maturation of male and female florets on maize plants frequent in hot summers ; it is claimed that this method is very efficient. When tested under farm conditions in Ukraine the yield was from 10 to 187 per cent higher, thus showing that it may be a useful addition to the agrotechnique of those plants in which there is a discrepancy in time of maturation of male and female florets owing to seasonal conditions.

3. Prostrate Orchard,
by A. D. Kizjurin, Agricultural Institute, Omsk. (pp. 43, with 24 text figures.)

The basis of this new system of cultivating fruit trees studied under severe winter conditions in Siberia is that from an early stage of growth the trees are trained to

grow within 25 to 30 cm. of the soil by bending them to the ground; where the snow cover in winter may be blown off by winds the trees should, in addition, be hoed in the autumn and snow-binding plants, such as maize, sunflower or sorghum, should be planted. It is claimed that with this method of cultivation even southern races, such as apricots or cherries, are able to live safely through a severe winter.

4. Perennial Varieties of Agricultural Cultivated Plants, by A. I. Deržavin, Experimental Farm of Perennial Crops, Voroshilovsk, North Caucasus. (pp. 41, with 20 text figures.)

Whenever possible the author recommends the replacement in agricultural practice of annual forms by perennial, which, in his opinion, are superior in a number of characters and in yield. The size of yield, it is claimed, is closely related to the type of roots. Annual plants must form roots each year, for which approximately half the organic substances elaborated by the plants is expended. The perennial plants from the second year onwards live mainly on already existing roots and are thus able to develop a vigorous aerial system during the second and subsequent years. With the exception of maize, which crosses readily with the perennial *Euchlaena* and *Tripsacum* species, and wheat, which crosses with the perennial forms of *Agropyron* and *Secale*, almost all the main agricultural annual crops have perennial representatives which, if not suitable for immediate introduction into practice, may nevertheless be used for building up perennial cultivated forms. Among these the following plants are briefly described with reference to their use in breeding, as tested by the author and his associates.

Barley has four perennial species, among them *Hordeum bulbosum* L. (found to be insufficiently winter hardy), *H. secalinum* Schreb. and *H. europaeum* All., failed to cross with annual cultivated forms; *H. violaceum* Boiss. was not studied by the author. In addition to these species, the closely related genus *Elymus* may be useful. There are several perennial species of rye, among which *Secale anatolicum* Boiss., *S. montanum* Guss., and *S. Kuprijanovi* Gross. proved to be particularly winter hardy; in addition, the last mentioned contains summer races. *S. africanum* Stampf. was not studied.

There are many perennial forms of *Sorghum*, but of these only *S. halepense* Pers. was studied; a non-rhizomatous race was found in which the rhizomes formed aerial parts. Millet has few perennial forms, including *Panicum capillare* L., *P. virgatum* L., and *P. bulbosum* L.; the last mentioned, a winter hardy plant resembling Sudan grass, was studied by the author. Among perennial forms of oats, *Avena pubescens* Huds., *A. pratensis* L., and *A. sempervirens* Host. proved to be perennial summer and winter-hardy species.

Of the perennial species of *Lathyrus* the author thinks highly of *L. rotundifolius* Willd., *L. latifolius* L., and particularly *L. silvestris* L., the last of which includes forms producing high forage yield and large grains. *L. tuberosus* L. produces many leaves, thin stems and tubers with a high sugar content and is considered to be very suitable for building up all-purpose varieties for grain, hay and tubers. Vetch

has many perennial forms, among which *V. sepium* L., *V. sylvatica* L. and particularly *V. cracca* L. are outstanding in value. *V. cracca* includes races with different root structures. *Phaseolus* has also a few perennial species, but all the specimens of *P. perennis* Nalt. and *P. tuberosus* Laur. (other species are not found in the Soviet Union) were not sufficiently winter-hardy. None of the perennial species of the genus *Cicer* occur in the Soviet flora.

In the Soviet Union there are two perennial species of lupin, *L. perennis* L., and *L. polyphyllus* Lindt., but both these were non-hardy and winter forms. The author failed to find perennial species or forms in lentils and soybeans, although their existence is not excluded.

Among other herbaceous plants of interest are the perennial species of sunflower; among them the tuber-bearing *Helianthus* (*H. tomentosus* Michx., *H. tuberosus* L., and *H. rigidus* Desf.) are considered to be suitable for building up all-purpose crops for grain, silage and roots, while *H. maximiliani* Schrad. and *H. divaricatus* may be suitable in the production of perennial varieties resistant to fungous diseases.

In conclusion the author summarizes his own research on the formation of perennial forms of wheat by hybridization with *Agropyron* and *Secale*, perennial sunflower and perennial cultivated forms of vetch and *Lathyrus*.

5. Simultaneous Ripening Hemp,
by N. N. Griško, USSR Institute for Hemp, Gluhov, Ukraine.
(pp. 51, with 20 text figures and a coloured plate.)

The author has bred a new variety of hemp in which the male and female plants mature simultaneously. In addition to the theoretical premises upon which the breeding of this variety was based, the author discusses polymorphism and cytogenetics of sex in hemp and transformation of sex as affected by internal and external factors.

6. A New Potato Variety No. 8670 Resistant to Phytophthora,
by I. I. Puškarev, Institute of Potato Husbandry, Moscow (pp. 44, with 10 text figures).

This publication deals with the agricultural analysis of a new variety, an interspecific hybrid between *Solanum demissum* and cultivated forms, and a discussion of the principles of phytophthora-resistant varieties.

7. What Does Wheat-Couch Grass Hybridization Give Us?
by N. V. Cicin, Siberian Institute of Grain Husbandry, Omsk.
(pp. 43, with 14 text figures.)

The author summarizes his results of hybridization of *Triticum* and *Agropyron*, which have been published in numerous papers noted in *Herb. Abstr.* The hybridization aimed at the production of grain, forage, and grain-forage perennial crops. The resistance of *Triticum* and *Agropyron* forms and their various hybrids to frost, drought and diseases is also discussed and the pamphlet concludes with notes on the baking quality of the grains of the hybrids and their parents.

8. News in the Cleaning and Grading of Seeds, by N. N. Urlich, USSR. Institute of Mechanization of Agriculture, Pljuščevo, Leningrad Railway. (pp. 64, with 27 text figures and four figures on separate plates.)

In the first part of the book the possible utilization of the correlation of measurements of seeds is discussed with special reference to new technological principles for the separation and gradation of seed. The discussion is supplemented and illustrated by examples of the separation of mixtures such as oats + barley, wheat + *Fagopyrum tataricum*, and wheat + *Polygonum convolvulus*. Triangular holes were used to separate wheat seed deficient in plumpness and rotundity of form. In this connexion the question of the degree of deficiency in the form of the seed is discussed and the coefficient (ratio between perimeter of cross section and that of circumference, equal to area) is introduced for the convenience of agriculturists in grading seed in this respect. A simple method is given to express the degree of deficiency of plumpness and rotundity of seed form through the "sailing faculty" of the seed, that is, the force required to suspend the seed in the air. The rest of the pamphlet is devoted to a comparative study fo the technological processes of cleaning and grading machines, built by "Reber", "Sojuznarkomzem" and the author himself. The working principles of the author's models are exemplified by the separation of *Berberis vulgaris*, *Polygonum convolvulus*, and large-grained vetch from wheat seeds. The final chapter deals with the principles of separation and the separators with a stationary tray constructed by the author in collaboration with T. S. Žegalova. The movement of seeds down the tray is based upon their weight, while the shift of seed within the seed current (grading) is effected by alternating air pressure. Finally, the physical properties of the seed surface (clover and *Cuscuta*) are discussed with reference to their utilization for the separation of seed of cultivated plants from weed seed.

9. A New Method of Determining Seed Germination, by A. A. Gurevič, Timirjazev's Agricultural Academy, Moscow. (pp. 27, with 2 text figures.)

According to the method described by the author, the vitality of seed is determined by the ability of living cells to restore through the respiration process ortho- and para-dinitrobenzol (Lipschitz, 1920). Nitrophenyl-hydroxylamine and nitraniline, the end products of dinitrobenzol, are, owing to the difference in the oxido-reduction potentials, differently absorbed by the tissues. The subsequent treatment of seeds which had been previously soaked in dinitrobenzol with an ammonium solution for about 15 min. at 40-45°C. stained the embryonic tissues, a reaction which is readily seen by dissecting the seed through the rootlets and the endosperm. The principles of diagnosis in cereals, on which this method was elaborated, are as follows. In an entirely sound seed the embryonic tissues surrounding the rootlet and shield (scutellum) do not stain; the staining of the rootlets is not uniform; for example, the dermatogen and plerome stain more intensely than the periblem. Dead seed do not stain. If all the embryonic tissues are dead, and only the aleurone cells are

potent, the entire embryo and endosperm take up stain, the embryo apparently staining " passively " through the diffusion of nitrophenyl-hydroxylamine from the endosperm. If the rootlets are dead, while the embryonic tissues around them and the shield and aleurone cells are alive, the rootlets and the surrounding tissues and the shield do not stain, but the endosperm stains intensely.

This method has been repeatedly tested on rye, wheat, oats (seed should be freed from the glume) and barley (glume should be removed from the embryo) (*Herb. Abstr.* 7. 44. 1937). The seeds are to be soaked in a non-crystallized dinitrobenzol for five hours at room temperature, or for an hour at 40 to 45°C. The time required for determining seed vitality does not generally exceed two hours when tested at high temperature. The data obtained by this method approximate to those obtained by actual germination. The description of the method is accompanied by some considerations of the theoretical aspects, and the work is concluded by brief instructions.

10. Two Crops of Grapes in a Year,
by V. S. Suškov, USSR. Institute of Viticulture, Magarach, Crimea.
(pp. 14, with 2 text figures.)

This issue deals with experiments in which the author succeeded in obtaining two crops in a season by summer pruning during flowering, the second crop ripening 5 to 6 weeks after the first. Presumably, the summer pruning also interferes with gametogenesis, as varieties otherwise incapable of self-pollination formed florets which were pollinated by their own pollen. This method can apparently be applied with suitable modifications to other, particularly horticultural, plants and reveals an interesting connexion between the time of flowering and the time of initiation of the fruit spurs of the following year (*Herb. Rev.* 5. 34-9. 1937.)

11. Intravarietal Hybridization,
by D. A. Dolgušin, Institute of Plant Breeding and Genetics, Odessa.
(pp. 28, with 13 text figures.)

This is in the nature of a supplement to the first issue ; although the theoretical grounds of intravarietal crossing, as advocated by Lysenko, are also reviewed, this publication is primarily intended to examine the technique and efficacy of the method, preventing, it is alleged, degeneration of a pure line and suitable for application on a large scale. Instead of the orthodox emasculation of self-pollinating florets (chiefly wheat) the spikelets are beheaded in such a way as to ensure the complete destruction of stamens in all the spikelets ; with this method the stigma of the middle spikelet is also damaged and this spikelet usually dies. Cross-pollination is affected by wind. With this method of emasculation and pollination the grain set in all the spikelets is quite normal.

12. Nipping of Cotton,
by T. D. Lysenko and A. A. Avakjan, Institute of Plant Breeding and Genetics, Odessa. (pp. 20, with 11 text figures.)

The theoretical bases of nipping (removing the tip and the vegetative shoots below the first sympodium) are examined. It is claimed that nipping of cotton plants regulates the movements of nutrients and thus prevents, or at least reduces, shedding of buds; with this method the number of florets on a spur was increased and their development speeded up. Consequently, the harvest before and after frosts was much increased when this method was tested in 1936 on a large scale in many farms of Ukraine and North Caucasus. It is recommended that nipping is carried out in two processes; when the first spur has been formed, all the vegetative shoots should be removed, and later, when the fourth or fifth spur has appeared, the tip should be nipped off.

13. The Drop Method of Analysis of Virus in Plant Breeding,
by M. S. Dunin and N. N. Popova, USSR Institute of Plant Protection, Moscow. (pp. 46, with 14 text figures and a coloured plate.)

In its main outline, this method for the phytopathological test of plants is based upon the antigenic properties of plant virus and consists in mixing a drop of sap squeezed from the leaves with a drop of specially selected serum which varies with plant and disease. The samples for analysis may be stored dry, while the serum may be kept as a powder; the glass slide may be substituted by unbreakable acetilcellulose. The possibility of using dry serum mounted on the slide simplifies still further the outfit required for this method, which owing to its simplicity can be readily used under field conditions by the layman. A comparison of this method and that of inoculation gives almost identical results, thus showing that simplicity is combined with a high degree of accuracy.

Without dealing further with the wide application of this method in phytopathology, it should be noted that it was successfully used with appropriately selected serum for discriminating between vernalized and unvernalized seeds of lupin, thus giving the hope that it may become a simple field method of diagnosis of plant development, which is much in demand. It is claimed that the method will also be useful in vitamin and hormone analyses as well as in the diagnosis of bacterial diseases.

14. A New Cultivator and Plant Feeder,
by F. M. Soloveĭ, USSR. Institute of Sugar Industry, Moscow. (pp. 36, with 19 text figures.)

This is a special type of cultivator which can be used both for cultivation of interspaces and for applying liquid and dry fertilizers. The construction of the equipment, its working principles and the results of official test are discussed and illustrated in detail.

15. News in the Curing of Mange in Domesticated Animals, by M. P. Demijanovič, State Institute of Veterinary Dermatology, Moscow. (pp. 33, with 13 text figures.)

The introduction into agricultural practice of hyposulphytotherapy is examined with special reference to the effect of hyposulphyte and sulphuric acid on mange.

16. Re-building the Nature of Plants by Transplantation, by S. P. Lebedeva, Institute of Vegetable Husbandry, Moscow. (pp. 42, with 22 text figures.)

In the first chapters the author summarizes results of her experiments on grafting begun in 1925 in Voronezh and later continued in Moscow. Large-scale experiments with various representatives of the Solanaceae and Cucurbitaceae showed not only the possibility of growing southern plants such as melons in the open in Moscow, but also provided comprehensive material on questions relevant to the inter-relations between scion and stock, the significance of assimilating parts in root development, the process of coalescence of scion and stock and other theoretically important and much disputed questions which are examined in the remainder of the pamphlet. Results quoted indicate strongly that on coalescence the scion and stock form, as it were, a physiological unit and that this union leaves a deep impression not only on earliness, the distribution and number of female flowers, root systems, quantity and quality of fruits, increased size of seed, winter hardiness of scion etc., but also on the progeny, the plants from seed of grafted individuals being earlier and more winter hardy than the control. This is described by the author as the "after-effect" of grafting and is regarded as a method of inducing permanent changes in the genotype. The technique of grafting is described in detail, and the importance of retaining the assimilative parts of the stock for successful coalescence is emphasized.

17. Hot-Bed Combine, by V. S. Mkrtčijan Institute of Vegetable Husbandry, Moscow, (pp. 29, with 21 text figures.)

In order to mechanize cultivation of plants under glass, the author suggests the construction of new special hot-beds of a larger size (100 m. × 2.6 m.) arranged parallel 0.7 m. apart, which enable agriculturists with a specially designed trolley engine to mechanize 22 different types of work thereon. The closing and opening of the glass frames are done by the engine with special fitments. The mechanization of laying hot-beds is effected by various outfits attached when required to the engine.

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The subsequent issues of this series will be dealt with as they are received by the Bureau.—M.A.O.

ECOLOGY IN AGRICULTURE

THE significance of the science of ecology, which was described by its founder, E. Haeckel, as the study of the interrelationship between the organism and its habitat, received a wider appreciation by Elton, who considered that ecology, more than any other branch of science, is capable of rendering practical aid to laymen. Indeed, the agronomist, according to Keller, acts first of all as a practical ecologist, endeavouring to fit together the dynamics of an environment and of plant development as closely as possible in order to gain the fullest advantage from the plant. In Keller's opinion " ecology is a study of the peculiarities of forms, structure, chemical composition and the entire life of a plant in the closest possible relation and interaction with definite characteristic combinations of environmental conditions in their dialectic unity." It thus appears to be the science nearest to agriculture, linking physiology, anatomy and biochemistry with everyday practice, bringing the results of laboratory studies into the open, the field of man's action. Despite its recent origin, there has now been collected on the subject of ecology an extensive body of experimental evidence, much of which has not yet found its way into practice.

Agronomists do not as a rule give due attention to the ecological aspects of soil preparation ; meanwhile, as stated by Lebedev (Lebedev, S. P. On the organization of ecological research in agricultural plants. *Sov. Bot.* No. 6. 1937. pp. 42-55.) any preparation of soil has a definite effect on the light, temperature, water and air environment of the soil, which in turn deeply affects the growth, development and general well-being of the plant. In connexion with the geographical variation of characters, plant breeders do not give enough consideration to the establishment of optimal conditions for each variety bred in a given locality, nor has due consideration been given to mutations arising in seeds under various conditions of storage. Soil scientists almost entirely disregard the vegetation as an expression of the chemical and physical properties of soil, which are of such importance in the reclamation of new land, cultivation of marshlands and grassland, not to speak of their close association with the general well-being of the plants. In reporting the general climatic features of a locality, meteorologists almost entirely neglect the study of the microclimate of the soil and the air layers immediately above the ground level, the environment in which the plant actually lives.

In this connexion, of rather general interest is the programme of ecological research with reference to development and yield of agricultural plants, drawn up by S. P. Lebedev and given below in a condensed form :

(1) The effect of light : optimal light conditions for plants and their varieties at different phases of their life ; the efficacy of various methods of influencing the light environment ; regulation of light conditions in ecologically different environments.

(2) The effect of temperature : optimal temperature for plants and their varieties at different phases of their life ; the efficacy of various means of influencing the temperature of the micro-climate of the soil and the layer of air just above the ground ; resistance of plants to low and high temperature throughout their life.

(3) The effect of moisture and rainfall; the optimal conditions for each variety; regulation of air moisture by means of various agronomical methods in ecologically different environments.

(4) The effect of overground air and soil air: the dynamics of gaseous exchange between the soil and the atmosphere; the structure of water-permeability of the soil; the composition of the soil air; the effect of various components of the air on the plant at various phases of its life; regulation of air environment of the soil by agronomical methods.

This list of course cannot claim to be exhaustive but, considering our meagre knowledge of these fundamental problems, the items may be regarded as deserving immediate attention. The isolated study of a factor, as V. H. Blackman showed, is not, however, sufficient, as the plant responds to the entire complex effect of interrelated factors. Moreover, these complex effects must be studied with the closest reference to plant development, as Lysenko showed that "ecologically" the plant varies with its advance towards reproduction. Again, Kostjučenko and Zarubaĭlo and other investigators have shown that in any ecological study the conditions under which the plant completes its embryonic period (seed ripening) must not be neglected. Finally, in ecological studies it is very desirable to record the daily and seasonal dynamics of climatic factors as accurately as possible, as the plant responds not to a daily average of any particular factor, but to its daily variation and range. In particular, the temperature around the plants should, whenever possible, be thermographically recorded, or at least the daily maximum and minimum must be taken. In recording daylight it should be borne in mind that the intensity and quality and hence the effect of the daylight vary throughout the day, as shown by Razumov and others.—M.A.O.

TAXONOMY OF BROMUS

[Reviewers : R. O. WHYTE and THOMAS BOGYÓ]

IN connexion with the identification and revision of the species of *Bromus* gathered by A. Pénzes on his journey in Bulgaria in 1929, much attention had to be devoted to each group of this huge genus, which extends to the five continents. (Pénzes, A., Rozsnok (Bromus) tanulmányok. Notes on Bromus. *Bot. Közl.* 33. 98-138. 1936.)

As in every case when the members of a genus are numerous and difficult to describe, different explorers have made determinations of different value and the author's aim is to revise these. A search was first made for new characters, which could be used for elucidating the sometimes apparently indistinct differences between species. Form, length and breadth of the lemmas were examined first, as other authors had done, but this method did not provide definite results. Much more important for identification are the veins and the number of veins in the lemma, which have been neglected altogether. These, however, can be seen only when the lemmas are held up to the light and examined at 8 to 10 times magnification.

AWNS

The length and curvature of the awns are important and heritable characters, but as there are many intermediate forms one can use them only for classification of the groups within a species. The lack of awns in *Bromus secalinus*, which grows in the cereal crop, can be traced to unconscious selection during the threshing of the grain crop. The awns have a role in spreading the grains ; they adhere readily to hairs of animals and human clothes and protect the ripe grains from being eaten. Larger and more numerous awns are generally produced under a warm and dry climate.

TRICHOMES

The presence and type of trichomes may be characteristic for some species, for example, on the culms of *B. commutatus* or the lemmas of *B. intermedius*. In other species this is a parallel genotype which appears mixed (glabrous and pubescent) in some cultivations, for example, lemmas of *B. japonicus* and *B. tectorum* and the lemmas and culms of *B. squarrosus*.

PANICLE

The spreading of the panicle and length of the branches are heritable characters, but in some cases, especially on the longer branches, the proportions depend upon the environment (light, nutrition, etc.). In the small groups of the sub-genera we can arrange them progressively according to the looseness or compactness of the panicles, for example, *B. pectinatus-Semerzovii-Szabói-scoparius*.

Spikelets

The length of the spikelets depends upon the number of florets it contains; this is generally constant, but their number increases owing to the effect of nutritive salts and higher temperature, while it decreases in a cool and humid climate, for example, in *B. squarrosus*, *B. grandistachys*, *B. japonicus* f. *triestina*.

Lemma

The length, breadth and appearance of the lemmas are very similar and can be distinguished only by exact measurements; in some cases only the constant and heritable differences *in size* are decisive, for example, in *B. japonicus* and *B. Abolinii*, *B. mollis* and *lepidus*. An attempt was therefore made to complete the old imperfect and too general descriptions with exact measurements and drawings.

As already mentioned, the number of veins in a lemma is an important character; seven and nine are the constant and heritable numbers of veins; in 11-veined species, which are younger forms, the intermediate, undeveloped veins are common, for example, in *B. squarrosus* ssp. *typicus*, the number is 11, in *B. squarrosus* ssp. *danubialis* the number 9 is more common.

The incision on the top of the lemmas is also a very characteristic mark, but this becomes torn as a result of quick drying and a cursory examination may result in an incorrect determination. Under a higher magnification the torn piece may readily be seen. Boissier's *Bromus phrygius* is incorrectly determined as he describes long incisions which cannot be found when the original specimens are examined. Like the awns, the lemmas also become enlarged under a drier, warmer climate. The cause of this phenomenon—whether it is due to the increase of osmotic pressure with the juice condensed through a larger surface, or (in connexion with the considerable assimilation surface) to the increase in height of the assimilating organs above the hot ground—requires further research. As a matter of fact, *B. squarrosus*, which has large lemmas, grows on the drifting, sometimes very hot, sand of the Hungarian Plain, while *B. japonicus* with smaller lemmas prefers the loamy plant-covered and hence cooler places. In the more loamy soils of the hills of Buda the two species are frequently found together, but *B. squarrosus* goes higher into rocky and stony hillsides, where it belongs to the *Stipa Joannis—pulcherrimma* association. In the Bulgarian Mount Pirin it climbs to a height of 1,200 to 1,300 m.

Caryopsis

The taxonomical value of the caryopsis is small owing to the fact that there are only limited differences in size. In most cases one cannot even determine them, as the herbarium specimens are usually rather unripe, or only half ripe. (Ripe spikelets would fall to pieces.)

Stamens

The length and breadth of the stamens are important and easy to determine. There would appear to be no difference between the species with short and long

stamens as regards the opening of flowers, as the flowers of the species *B. inermis*, *B. arvensis*, *B. commutatus*, *B. japonicus* and *B. squarrosus* were found to open in Budapest at sunset.

Cells and Tissues

The species of *Bromus* do not possess such good and valuable anatomical characters as are, for example, the sclerenchyma bundles of the *Festuca* leaves, but in their phylogenetical classification use was made of the anatomical paper of B. Szartorisz, in which he noted different sizes of starch grains to be characteristic of every section.

Phylogenetics

Among the revised species, *B. arvensis* can be regarded as the starting point of the members of *Serrafalcus*. C. Shear and Holmberg also take this as the starting point in their short phylogenetic notes. This species with its long stamens and 7-veined lemma is closely connected downwards with the subspecies *Festucaria*. *B. brachystachys* with its smaller awns and *B. intermedius* with its 2 veins but successively smaller stamens link up with *B. arvensis*.

On the basis of size differences in starch grains (2×2 to $3\ \mu$.) *B. intermedius* cannot be regarded as the starting point of every species, for example *B. mollis*, but only as a lateral branch.

The next branch is the group *racemosus*, which has also long stamens, but the lemma becomes successively broader in *B. secalinus*, *B. mollis*, *B. commutatus*, and *B. squarrosus*. To *B. racemosus*, or better to *B. arvensis*, is linked the 7-veined, short-stamened *B. pectinatus*, which was misunderstood and regarded by some as *B. japonicus*. Its geographical distribution (South Africa, Arabia, India, Japan, Australia) is an indication of its ancient character. *B. japonicus* provides a good connecting link through *B. Sewerzowii* to the *B. Szabói-B. scoparius* group, and on the other side to the more xerophytic and less widely distributed *Stenobromus* subgenus. As this is an intermediate form, the sizes of its starch grains are also not extreme (3.3×4 to $5\ \mu$.).

The widely separated subgenus *Triniusia*, to which belong species with trifurcate awns, is probably derived from the species *B. macrostachys* and *B. oxyodon*.

The subgenus *Neobromus* has also long stamens and 7 veins, but this is probably derived from an ancient branch of the genus around the Pacific Ocean and has no close connexion with *B. arvensis*.

Taxonomic Division of Bromus Species Described

Subgenus : *Festucaria* Godr.

Sg. : *Serrafalcus* Parl.

Sect. : *Arvenses* Pns.

Br. arvensis (*brachystachys*) *intermedius*.

Sect. : *Racemosi* Pns.

Br. racemosus, aegyptiacus, Tuzsonii.

Sect.: *Commutati* Pns.

Br. (*mollis*), (*lepidus*), *secalinus, commutatus, japonicus, Abolinii, squarrosus, brizaeformis, macrostachys,* (*Jávorkae*), *oxyodon.*

Sect.: *Pectinati* Pns.

Br. pectinatus, gedrosianus, Sewerzowii, Szabói, scoparius, (*Degenii*), *alopecuroides.*

Sg.: *Triniusia* (*Steud.*) Pns.

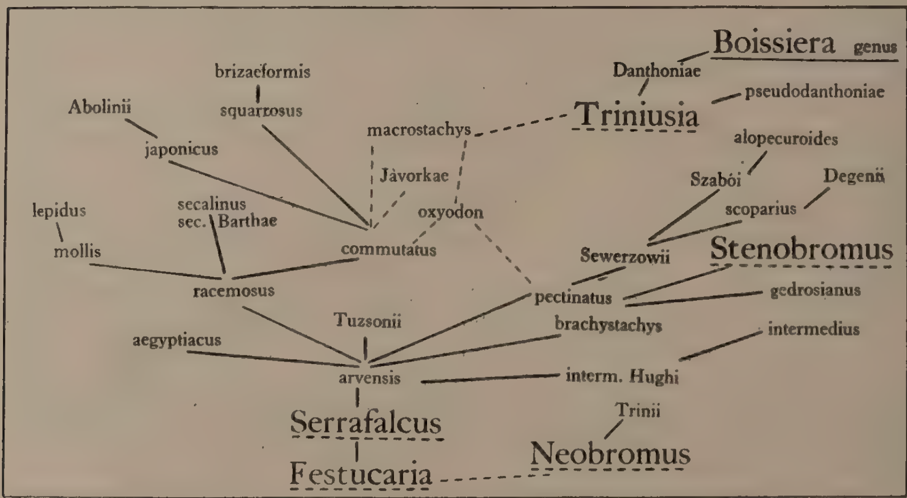
Br.: *Danthoniae, pseudodanthoniae.*

Sg.: *Stenobromus* Hack.

Sg.: *Neobromus* Shear.

Br.: *Trinii.*

The names in brackets are not described.



The phylogenetics of the *Bromus* species described by Pénzes.

In considering the above-mentioned data an attempt was made to describe the material and to obtain original examples and types. It was not always possible to do this as the genus is very large; this work, therefore, does not represent a monograph. It is known, however, that a monographic study cannot be regarded as a perfect whole, but only as one step in the evolution of a science, as a transient page of an album of the immense scientific material in nature.

Description and Enumeration of the Species

Details of the characters of the following species and of their geographical distribution are given in alphabetical order, together with a comprehensive series

of illustrations. A key for identification cannot be given as the series is not complete. Those synonyms which are described in the "Index Kewensis" and in Ascherson and Graebner (Synopsis der Mitteleuropäischen Flora 1898-1902) are not given here in order to save space.

1. *Bromus Abolinii* Drobov.
2. *aegyptiacus* Tausch.
3. *alopecuroides* Poir.
4. *arvensis* L.
   - v. *turcicus* n.v. comb.
5. *brizaeformis* Fisch. u. Mey. v. *thalysianus* n.v.
6. *commutatus* Schrad. v. *typicus* n.v.
   - v. *Györffyi* n.v.
   - v. *apricorum* Simk.
7. *Danthoniae* Trin.
8. *gedrosianus* n. sp.
9. *intermedius* Guss. v. *typicus* n.v.
   - v. *Hughi* (Tod.) Nym.
10. *japonicus* Thunb. ssp. *typicus* (Hack.)
    - v. *Chiapporianus* (De. Not.)
      - f. *bosnensis* n.f.
    - v. *grandis* (Vel.)
    - ssp. *phrygius* (Boiss.)
    - ssp. *anatolicus* (Boiss.) v. *typicus* n.v.
      - v. *Rapaicsii* n.v.
    - ssp. *subsquarrosus* (Borb.) v. *typicus* n.v.
      - v. *zomboriensis* (Prod.)
    - ssp. *Soói* n. ssp.
11. *macrostachys* Desf.
12. *oostachys* Bornm.
13. *oxyodon* Schrenk.
14. *pectinatus* Thunb. v. *typicus* n.v.
    - v. *vestitus* (Schrad.)
15. *pseudodanthoniae* Drobov.
16. *racemosus* L.
17. *rubens* L. v. *Borosii* n.v.
18. *scoparius* L.
19. *secalinus* L. ssp. *Barthae* n. ssp.
20. *Sewerzowii* Regel v. *typicus* Drobov.
    - v. *subglaber* Roshev.
21. *squarrosus* L. ssp. *typicus* n. ssp.
    - v. *Gomboczii* n.v.
      - f. *uberrimus* (Murbeck.)
    - ssp. *danubialis* n. ssp.
      - v. *wolgensis* (Jacq.)
    - ssp. *Noeanus* (Boiss.)
22. *Szabói* n. sp.
23. *Trinii* E. Desv.
24. *Tuzsonii* n. sp.

CANADIAN WEED CONTROL COMMITTEE

[Reviewer: R. O. Whyte]

In the United States it is stated that the annual loss to agriculture due to animal diseases has been estimated at $250,000,000; that due to diseases of the ten leading crops at $780,000,000; that due to insect pests $1,000,000,000; and that due to weeds $3,000,000,000. In Canada also it is considered that weeds stand pre-eminent among the causes of loss and consequently of increased production costs. Until recently, however, no adequate investigations have been in progress to obtain knowledge equivalent to that now existing on animal and plant diseases and pests.

"In recent years the exploitation by commercial firms of various chemicals as herbicides has provoked a renewed interest in this old, but never widely used, method of weed control. The National Research Council, in response to requests from numerous organizations, called a conference in Edmonton in the fall of 1929, on the destruction of weeds by means of chemicals. At this conference it became clear that the whole field of weed control was urgently in need of investigation. The Council then appointed an Associate Committee on Weed Control, with representatives of the chief institutions concerned in the general problem, and the committee undertook the task of developing a co-ordinated program covering all aspects of weed control investigations."

The preceding and following paragraphs are quotations from the foreword to the first publication of this Committee, under the Chairmanship of Dr. R. Newton, National Research Council of Canada, Ottawa; the Committee has the following composition:

H. M. Tory, President, National Research Council (*ex-officio*), Ottawa, Ont.
George Batho, Secretary of the Weeds Commission, Department of Agriculture and Immigration, Winnipeg, Man.
B. L. Emslie, Technical Promotion Manager, Fertilizer Division, Canadian Industries Ltd., Montreal, Que.
E. L. Gray, Field Crops Commissioner, Department of Agriculture, Edmonton, Alta.
A. H. Henry, Associate Professor of Plant Pathology, University of Alberta, Edmonton, Alta.
E. S. Hopkins, Dominion Field Husbandman, Central Experimental Farm, Ottawa, Ont.
L. E. Kirk, Dean of the Faculty of Agriculture, University of Saskatchewan, Saskatoon, Sask.
K. M. McKay, General Agricultural Agent, Canadian Pacific Railway, Winnipeg, Man.
G. P. McRostie, Department of Field Husbandry, Ontario Agricultural College, Guelph, Ont.
R. E. Neidig, Consolidated Mining and Smelting Co., Trail, B.C.
J. W. Shipley, Professor of Chemistry, University of Alberta, Edmonton, Alta.
F. T. Shutt, Dominion Chemist, Central Experimental Farm, Ottawa, Ont.
W. G. Smith, School of Agriculture, Raymond, Alta.
Major H. G. L. Strange, Chairman, Educational Committee, Canadian Seed Grower's Association, Fenn, Alta.

S. H. Vigor, Field Crops Commissioner, Department of Agriculture, Regina, Sask.
G. S. Whitby, Director, Division of Chemistry, National Research Council, Ottawa, Ont.
F. E. Lathe (*Secretary*), Director, Division of Research Information, National Research Council, Ottawa, Ont.

" Having regard to the practicability of organizing the work, it was agreed that the initial activities should have more particular reference to the prairie provinces. Mr. J. M. Manson, of the University of Alberta, was engaged by the Committee to make a reconnaissance survey of this area, in order that the Committee might have a better picture of the situation with which it was confronted.

" Special attention may be directed to a few of the significant findings. The survey was for the most part restricted to seven weeds judged by the committee to present the most serious problems in the prairie provinces, namely : perennial sow thistle, Canada thistle, wild oats, wild mustard, stinkweed, couch grass and poverty weed. Of these, only the last is native to this region and though difficult to eradicate by cultivation, it fortunately spreads rather slowly. All the others are introduced plants, and their prevalence has been found to be roughly proportional to the age of settlement in the various parts of the West. Thus it appears that unless more general and effective steps are taken to combat the weed menace, it is only a matter of time until all districts are overrun to the same extent as those which are now worst.

" The chief primary sources of infestation are claimed to be dirty seed and feed, either distributed in connection with government relief schemes, or brought in by farmers or contractors. As a result of using dirty grain in compounding dog feed, ' there is probably a trail of stinkweed right to the Arctic Ocean.'

" Secondary sources of infestation and spread include these primary infestations, especially when established in uncultivated lands, such as the margins of lakes, swamps, bird sanctuaries, vacant lands, irrigation ditches, and in poorly farmed areas, such as Indian reservations ; also the continued use by farmers of uncleaned seed, dirty feed grain, weedy hay and greenfeed, unrotted manure, itinerant threshers and farm equipment generally, etc.

" Cultural methods of control must be mainly depended upon, since the application of chemical herbicides is practicable only for small areas. For most of the weeds cultural methods have been developed, and we may expect great improvement along this line when we have available the results of the careful studies of the growth habits of weeds now being carried on by members of the committee. Previous progress has been achieved largely by the method of trial and error ; now it can be based on accurate knowledge of the effect of different treatments on the development of various weeds. It would appear that general control may in future be achieved in proportion as educational campaigns are successful in inducing farmers at large to co-operate in the application of the best methods. Community effort is essential, as with many weeds reinfestation from farm to farm takes place readily.

" Weed inspection systems might be improved by centralizing within each province the responsibility for both the appointment and supervision of inspectors,

and by extending the legislation to require the cleaning of seed. Municipal appointees are often poorly qualified and ineffective. The educational aspect of this work should be emphasized."

The following is a complete list of contents of the publication under review, entitled "Collected papers of the Associate Committee on Weed Control," published by the National Research Council of Canada, 1932-37. A reference is made to *Herbage Abstracts*, when a paper has been abstracted in that journal.

Paper No.

1. Manson, J. M. Weed survey of the prairie provinces. *National Research Council Report* 26. 1932.
2. McRostie, G. P., Kirk, L. E., Godel, G., Smith, W. G., and Manson, J. M. Weeds and their control. *National Research Council Report* 27. 1932.
3. Kirk, L. E., and Pavlychenko, T. K. Vegetative propagation of wild oats, *Avena fatua*, and other economically important species of *Aveneae* and *Hordeae*. *Canad. J. Res.* 7. 204-220. 1932.
4. Godel, G. L. Some considerations in regard to experiments with chemical herbicides. *Canad. J. Res.* 7. 499-519. 1932. *Herb. Abstr.* 3. p. 23. 1933.
5. Aamodt, O. S., and Malloch, J. G. "Smutty" wheat caused by *Ustilago utriculosa* on dock-leaved persicary. *Canad. J. Res.* 7. 578-582. 1932.
6. Bowser, W. E., and Newton, J. D. Decomposition and movement of herbicides in soils, and effects on soil microbiological activity and subsequent crop growth. *Canad. J. Res.* 8. 73-100. 1933. *Herb. Abstr.* 3. p. 93. 1933.
7. Padwick, G. W., and Henry, A. W. The relation of species of *Agropyron* and certain other grasses to the foot-rot problem of wheat in Alberta. *Canad. J. Res.* 8. 349-363. 1933. *Herb. Abstr.* 3. pp. 168-9. 1933.
8. Cook, W. H. Fire hazards in the use of oxidizing agents as herbicides. *Canad. J. Res.* 8. 509-544. 1933.
9. Pavlychenko, T. K., and Harrington, J. B. Competitive efficiency of weeds and cereal crops. *Canad. J. Res.* 10. 77-94. 1934.

9a. ——————————— Root development of weeds and crops in competition under dry farming. *Sci. Agric.* 16. 151-160. 1935.

10. Padwick, G. W. Influence of wild and cultivated plants on multiplication, survival and spread of cereal foot-rotting fungi in the soil. *Canad. J. Res.* 12. 575-589. 1935.
11. Newton, J. D., and Paul, A. D. Decomposition and movement of herbicides in soils and effects on soil micro-biological activity and subsequent crop growth. Part II. *Canad. J. Res.* Sect. C. 13. 101-114. 1935.
12. Pavlychenko, T. K. The soil-block washing method in quantitative root study. *Canad. J. Res.* Sect. C. 15. 33-57. 1937. *Herb. Abstr.* 7. p. 140. 1937.
13. Cook, W. H., and Halferdahl, A. C. Chemical weed killers. A review. *National Research Council Bull.* 18. 1937. pp. 111.
14. ——————— Chemical weed killers. I. Relative toxicity of various chemicals to four annual weeds. *Canad. J. Res.* Sect. C. 15. 299-323. 1937. *Herb. Abstr.* 7. p. 383. 1937.
15. ——————— Chemical weed killers. II. Factors affecting estimation of toxicity of leaf sprays. *Canad. J. Res.* Sect. C. 15. 380-390. 1937. *Herb. Abstr.* 7. p. 383. 1937.
16. ———————, Pavlychenko, T. K., Manson, J. M., and Garrow, P. Chemical weed killers. III. Relative toxicity of several chemicals to perennials under field conditions. *Canad. J. Res.* Sect. C. 15. 442-449. 1937. *Herb. Abstr.* 8. Abs. 420. 1938.

17. ———— Chemical weed killers. IV. Relative toxicities and loci of absorption of selected chemicals applied to perennials. *Canad. J. Res.* Sect. C. 15. 451-460. 1937. *Herb. Abstr.* 8. Abs. 421. 1938.

18. ———— Chemical weed killers. V. Relative toxicity of selected chemicals to plants grown in culture solution and the use of relative growth rate as a criterion of toxicity. *Canad. J. Res.* Sect. C. 15. 520-537. 1937. *Herb. Abstr.* 8. Abs. 422. 1938.

19. Pavlychenko, T. K. Quantitative study of the entire root systems of weed and crop plants under field conditions. *Ecology.* 18. 62-79. 1937. *Herb. Abstr.* 7. p. 146. 1937.

THE VEGETATION OF PETÉN

[Reviewer: Rosalind M. Whyte]

The greater part of the data and plant collections on which a special publication* has been based were obtained by C. L. Lundell as botanist and director of the 1933 Carnegie-Michigan expedition to the region. Very little biological exploration had been undertaken in this section of Guatemala previous to 1922, with the result that the area still remained a most fertile field for investigation.

The department of Petén is relatively isolated in that it is cut off from the south, southeast and southwest by mountains. It belongs orographically and geologically to the Yucatan peninsula. The department may be divided into northern, central and southern sections each having distinctive characteristics.

The northern section of Petén is described geologically and from the points of view of topography, drainage, climate and soils. One of its main characteristics is the presence of large numbers of sinkholes (aguadas) which apparently have been formed by subterranean erosion. Climatically the three divisions of Petén are similar in that they have a marked seasonal distribution of rainfall which divides the year into a dry (November to May) and a wet season (May to October). The history of the vegetation of the region and the occasional dominance of certain species are inextricably connected with the Maya occupation of the area. Agriculture in this northern forested zone is confined to clearings in the forest and is termed the milpa system. This primitive method of farming together with destruction by fire has denuded large sections of the country of climax forest. According to Cook, "the milpa system carries with it the agency of its own destruction in producing grasslands that are not amenable to the kind of cultivation that the system provides." The vegetation is classified under primary and secondary successional stages.

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*Washington, Carnegie Institution of. Publ. No. 478. The vegetation of Petén. With an appendix, Studies of Mexican and Central American plants—1. By C. L. Lundell. Washington. 1937. pp. 254.

The central savanna zone is characterized by broad, level, grassy flatlands intersected by conical, forested and denuded hills of resistant limestone. Considerable detail concerning the soils of this grassland region is given. The damage to the area by fire during exceptionally dry periods is severe, but it appears that the marginal forest which surrounds the grassland areas is fire resistant and prevents the destruction of the mesophytic forest. Fires are frequently caused by cattlemen, who burn to improve grazing conditions ; on the other hand some bush fires are due to milpa burnings. The burning of grasslands each year is probably a favourable factor in reforestation as with moderate ground fire conditions forest appears to be able to invade grasslands slowly. At present the damage to these grasslands is caused by fire and not by overgrazing.

Not a single endemic species was found in the savanna region, which suggests that the grasslands are of comparatively recent origin. Grasses dominate the vegetation with legumes next in importance. The marginal vegetation in the savanna country is undoubtedly the result of unnatural conditions which have arisen from denudation and the establishment of grasslands. The author's investigations indicate that the forest is invading the grasslands. In this reforestation it is the dynamic fire-resistant marginal-zone species which pave the way for the establishment of mesophytic forest.

The grasses forming the major vegetation of these areas are chiefly hardy perennials with deeply buried roots, corms or stolons. Prominent among these grasses are species of *Andropogon*, *Panicum* and *Paspalum*. Legumes are also very common in this area. The importance of the marginal forest cannot be overestimated. It is dominated by fire-resistant pioneer species variously adapted to conditions of exposure, excessive evaporation and desiccation.

As southern Petén is botanically still unexplored little detail is given in this publication. There is, however, an annotated list of the species which have been collected from the area similar to, if briefer than, the lists for northern and central Petén.

An appendix is concerned with taxonomic details of certain of the species represented in the region. Thirty-nine photographic plates give representative views of the vegetative types. A map of Lake Petén and two cross sectional diagrams showing topography and zonation of vegetation are also included in a separate folder.

CONFERENCES

Australian and New Zealand Association for the Advancement of Science

In *Herbage Reviews* for March, 1937, preliminary details were given regarding the twenty-third annual meeting of the Australian and New Zealand Association for the Advancement of Science, which was held under the presidency of Sir David Rivett in Auckland, New Zealand, on January 12 to 19, 1937. Further details may now be given of this meeting, extracted from the report edited by F. J. A. Brogan and published by the Association at its principal office, Science House, 157-161, Gloucester Street, Sydney, New South Wales.

The inaugural address, given by the President, was entitled "The scientific estate."

Among the papers read to Section D, Zoology, may be mentioned J. Davidson on "Bioclimatic zones in Australia," and a joint symposium by the Agriculture, Botany and Zoology Sections on the "Control of weeds." The opening address was given by G. A. Currie on aspects of weed control in Australia. The Weed Section of the Commonwealth Council for Scientific and Industrial Research, in co-operation with State Departments of Agriculture and the Commonwealth Prickly Pear Board, is carrying out investigations in this field, while noxious weeds legislation is enforced by State Departments and local bodies. The methods found successful in the biological control of prickly pear are being tested on such weeds as *Xanthium pungens*, *Hypericum perforatum*, *Lantana camara*, and *Senecio jacobaea*. Control of weeds by chemical methods is being used with *Chondrilla juncea*, *Cyperus rotundus* and *Brassica Tournifortii*. Control by modified pasture management, such as reserve stocking, is being tried for *Bassia Birchii*. Cultural methods are being tested for the eradication of deep-rooted perennials in arable land. Detailed life-history studies in the greenhouse and analysis of material from fortnightly harvest give information about the rate of growth, time and amount of seeding, nutritive properties, water requirements and food-storage mechanisms of each weed in turn.

The other papers contributed to this symposium were an account of progress of weed control research in New Zealand by David Miller, a paper on the insect control of Piripiri (*Acaena* spp.) by David Miller and J. M. Kelsey, and chemical weed killers in New Zealand by J. A. Bruce.

The presidential address to Section K, Agriculture, was entitled "The classification and mapping of soils," and was delivered by Professor J. A. Prescott. This was followed by other papers: "Grassland farming in New Zealand," by P. W. Smallfield (see p. 158 of this issue of *Herbage Reviews*), "Manganese deficiency in Australia" by C. S. Piper, "Recent developments in artificial drying of forage and other crops,

with special reference to nutritional aspects," by M. C. Franklin, and a discussion entitled "Plant types as found in crested dogstail (*Cynosurus cristatus*)", by W. A. Jacques.

A joint discussion was held on the plant and agricultural aspects of mineral deficiencies, with the Chemistry Section. The following papers were contributed:

Askew, H. O., and Dixon, J. K. Influence of cobalt top-dressing on cobalt status of pasture plants. *Herb. Abstr.* 7. 268. 1937.

Rigg, T., Askew, H. O., and Chittenden, E. Brown heart of swedes and turnips. *N.Z.J. Sci. Tech.* 18. 750. 1937.

Leech, W. D. Toxic elements: boron, fluorine and selenium.

Grimmett, R. E. R. Notes on the toxicology, methods of estimation, and biochemistry of zinc. *N.Z.J. Agric.* 54. 216. 1937.

The presidential address to the Veterinary Science Section was entitled "Recent contributions to veterinary science by Australian and New Zealand workers" and was delivered by Dr. J. A. Gilruth (since deceased).

The presidential address to the Botany Section was delivered by Edwin Cheel, entitled "A review of the flora of the arid and semi-arid regions of Australia." This paper contains sections dealing with forage and other plants of economic importance, drought problems, soil erosion problems and erosion control. One of the papers delivered to this section was entitled "Some correlations between vegetation and climate in New Zealand," by V. D. Zotov.

Dr. C. T. Madigan delivered the presidential address to the Geography and Oceanography Section on "A review of the arid regions of Australia and their economic potentialities." Among the papers delivered to this section was that by A. G. Lowndes and W. H. Maze on "The land utilization regions of Tasmania," *Herb. Abstr.* 8. No. 3. 1938.

The full text is given of the Liversidge lecture read by Theodore Rigg on the subject of "Soil deficiencies in New Zealand."

Conference on Pedology and Plant Physiology, Saratov, U.S.S.R.

In the preceding issue of *Herbage Reviews* (pp. 120-1) a preliminary note was published regarding this Conference. The Bureau has now received the Proceedings (Trudy) of the Conference published by the State University, Saratov, in two volumes.

The physiological section was represented by five sessions (one in conjunction with the soil fertility session), during which twenty-five reports and communications were read. To the number of papers already noted in these columns, the following should be added.

E. I. Vorobjeva. The significance of perennial herbage plants in the formation of soil structure.

E G. Petrov. The effect of irrigation and the micro-climate under irrigation on photosynthesis and transpiration.

E. I. Ratner. Salt content of soil and plant.

F. D. Skazkin. The anatomical and physiological study of the periods which are critical for oats as regards water deficiency of soil.

A. D. SMIRNOVA and V. E. ŠESTAKOV. The changes in nitrogen content in relation to hydrocarbon accumulation and winter hardiness in winter wheat during the second developmental phase.

N. G. POTAPENKO. Study of the entry and movement of nutrients in plants.

A. D. SMIRNOVA. Pre-sowing treatment of seeds according to Henkel's method.

The sessions of the physiological section were presided over by N. A. Maximov, Saratov, P. A. Henkel, Perm, and T. A. Krasnoseljskaja, Leningrad.

Not all the reports and communications have been published in these Proceedings, for example, the plenary address on the subject of salt resistance in plants by N. A. Maximov, as this was not ready for publication when the Proceedings went to press. It is hoped to include an English translation of this particular address in a future issue of *Herbage Reviews*. Abstracts of other papers which come within the scope of the Herbage Bureau will be dealt with as usual in the appropriate section of *Herbage Abstracts*.—M.A.O.

Biochemical Association of the Academy of Science in U.S.S.R.

The meeting of the Biochemical Association held in Moscow on April 16 and 17, 1937, to discuss the heredity and variability of biochemical properties in the plant kingdom has given another indication of the increasing tendency in plant breeding to seek the help and support of physiological and biochemical studies of the internal environment of the plants being bred. Of thirteen reports discussed at that meeting, which was presided over by Academician A. N. Bach, twelve have been published in *Izvestija Akademii Nauk S.S.S.R.* : *Otdelenie matematičeskih i estestvennyh Nauk* : *Biologičeskaja seria*, No. 6. 1937 ; the thirteenth report would appear to have been rejected by the meeting, but has been discussed in brief by the late Academician V. N. Ljubimenko in *Sov. Bot.* No. 4. 1937. pp. 107-8. No journal or proceedings of this meeting have to our knowledge been published, and the reports discussed below are presented in an arbitrary order.

A. A. Schmuk reporting on " The chemical composition of alkaloids in interspecific hybridization of *Nicotiana* plants," showed that the chemistry of the alkaloids varied with the species, *N. tabacum*, *N. rustica* and *N. Langsdortfii* containing nicotine, *N. Sylvestris* and *N. Rusbyi* the alkaloids of the secondary bases (presumably nornicotine), and *N. glauca* anabasine. No new alkaloid compounds were found in their hybrids, these containing only the alkaloids of the parent plants, although sometimes represented in different ratios. The first generation generally contained one of the alkaloids found in the parent ; subsequent generations segregated widely and the forms were found to contain a mixture of alkaloids and one of the alkaloids.

V. I. Nilov emphasized in his report on " Some regularities in chemical changes in plants" that plants undergo deep qualitative and quantitative changes in ontogenesis. The qualitative changes were found to be isomerous, frequently connected with some changes in the structure of the carbohydrates and with oxido-reduction. The oxidation and reduction and consequently the end-products were found to vary

with the organs. The cycle of elaboration of substances was, however, fairly stable within the species studied. It is claimed by the reporter that his results suggest an entirely unexpected approach to the breeding of oleiferous plants and throw some light upon the genesis (elaboration and transformation) of terpenes.

Thus these two investigators, both stating changes in plant chemistry due to hybridization, the former in the alkaloids and the latter in ethereal oil, have arrived at apparently conflicting conclusions. Schmuk observed only quantitative changes, whereas Nilov concluded that new compounds could be obtained by re-synthesis. Both, however, made a contribution towards the better understanding of the evolution of the chemical composition of plants and hence to a conscious breeding of new agricultural forms of a required standard.

" The law of heredity of chemical characters in Cucurbitaceae in relation to plant breeding " was reported by V. V. Arasimovič, who found that sugars, acidity, cellulose, pectins, albumens and ash are inherited independently of each other, and that even different forms of sugars (glucose, fructose and saccharose) were independent. In the first generation heterosis as regards sugar and albumen content was reported. In the second generation segregation was observed for these characters, related with the polymerous gene constitution varying with the species. The chemical composition of a wild form was dominant in the first generation. On the whole, results show that wild forms endowed with a number of useful characters can be used for building up new varieties.

Of particular interest is the report of A. I. Oparin, " The enzymatic system as the basis of physiological characters in plants," in which he summarizes the conclusion previously made (*Herb. Abstr.* 8. Abs. 1284. 1938), namely, that the synthesizing activity of cells is effected by the enzymes absorbed by the protoplasm, while the hydrolytic activity is carried out by the same enzymes, but in a dissolved state. The ratio between these two forms of the enzyme seems to govern the chemical composition of the plants, and hence some of the physiological characters are, it is claimed, dependent upon the ratio between the " hydrolytic " and " synthesizing " state of enzymes. The ratio is fairly stable in species and varieties, but is nevertheless liable to shift in either direction under the effect of the environment, thus suggesting a possible transformation of the enzyme from one state to another.

The report by V. A. Rubin on " The direction of the action of enzymes as the basis of varietal difference in cultivated plants," which established the correlation between earliness, the activity of certain enzymes and the energy of hydrolytic and oxidizing processes, and that of N. M. Sisakjan on " The direction of the action of invertase as an index of drought resistance and earliness in cultivated plants " (*Herb. Abstr.* 8. Abs. 1285. 1938) confirmed the conception advocated by Oparin. The report of S. S. Elizarova on " The inheritance of enzymatic characters : catalase in barley ", which showed that the activity of catalase is a genotypical character in barleys of different origin, also agrees with Oparin's theory, as does a report recently published by A. L. Kursanov and others (*Herb. Abstr.* 8. Abs. 1283. 1938), which brings evidence from the study of invertase. This group of reports thus

deserves particular notice as it establishes the physiological significance of enzymes and the relation of their activity and direction to a number of important characters such as sugar content, earliness and drought resistance.

The importance of biochemical studies in relation to plant breeding was emphasized by N. N. Ivanov in his report on " Breeding plants for chemical composition," in which he stressed the need to classify varieties biochemically, and pointed out that varieties appear as a response to the environment during their ontogenesis and after-harvest maturation. Emphasizing the importance of the chemical point of view, he considers that biochemists must play a direct part in building up new strains. He also described the methods of determining chemical composition of seeds without damaging their vitality, which, he maintained, will considerably speed up breeding for a requisite chemical constitution.

A. I. Ermakov, in reporting on " The interspecific and individual variation of oil content in seeds ", drew attention to those geographical regions in which the climatic, edaphic and other ecological factors lead to the occurrence of the greatest number of plants with a high oil content. He also reported on the individual changes in chemical composition which may be of value in breeding. The significance of ecological factors was still more emphasized by S. L. Ivanov in his report on " The climatic variation of chemical composition of plants" (*Herb. Abstr.* 8. Abs. 1213. 1938), where he summarized the recent advances made in the study of the effect of climatic factors on the chemistry of plants and the foundation of biochemical evolution. The evolution of chemical composition was the subject of the report read by A. V. Blagoveščenskiĭ (hitherto unpublished), in which it was pointed out that, parallel with the evolutionary complication of plant organization, substances with little activity accumulate progressively with the result that the plants seem to reduce their adaptability to an ever-changing environment ; this, it is alleged, leads to destruction of species. It is claimed that similar " deterioration " is observed in ontogenesis and this progressive accumulation of cyclic compounds in the protoplasm may be regarded as phylogenetic and ontogenetic ageing of the protoplasm. Referring to his results obtained in the study of catalases, the author endeavoured to show that the " quality " of that enzyme was different, if judged by the amount of energy taken from outside for effecting the reaction, and that enzymatic potency was higher in phylogenetically younger plants. This idea, which as such is not altogether new and which was advanced previously by some biochemists, caused considerable discussion, and was condemned at the meeting. In the resolutions passed by the meeting, it was pointed out that this hypothesis " has not yet an adequate body of facts to support the correctness of the regularity claimed in the evolution in relation to phylogenesis. The meeting also notes that the point of view held by the reporter, according to which evolution leads inevitably to the destruction of organic life on earth, is not in proper harmony with the only correct evolutionary doctrine of Darwin."

The report of A. S. Okanenko was entitled " Materials on the biochemical characteristics of beet varieties " (*Herb. Abstr.* 8. Abs. 1314. 1938) ; the reader

stressed the physiological significance of roots in the elaboration and accumulation of sugars, as the grafting of leaves of sugar beet on the stock of fodder beet and vice versa showed that the accumulation of sugars and their dynamics in roots is predetermined not by the leaves, but by the specific function innate to the tissues of the roots. Finally, V. I. Tovarnickiĭ, reporting on " Materials on the biochemical characteristics of soybean varieties " (*Herb. Abstr.* 8. Abs. 1241. 1938), revealed some stable varietal differences as regards dynamics of carbohydrates and nitrogen during seed-ripening, which can be used successfully in the discrimination of varieties and for plant breeding purposes.

These thirteen reports, therefore, comprised a comprehensive body of experimental evidence, which justifies the creation of a new science which can be described as biochemical breeding, or rather physiological breeding, as the biochemical dynamics in plants must not be studied separately from the physiological significance of chemical substances in the plant organism.—M.A.O.

American Association for the Advancement of Science

The 1938 summer meeting of the Association and its affiliated Societies was held at Ottawa, Canada, from June 27 to July 2. An account of the proceedings is given in *Science*, N.S. Vol. 88. No. 2274. pp. 87 to 101. 1938. The following are some extracts from the proceedings.

Among the symposia which were organized were those on micro-elements and deficiency diseases, and drought relations (see list of papers under the heading of American Society of Plant Physiologists in this issue) ; also the symposium held in conjunction with the American Society of Agronomists and presided over by Dr. O. McConkey. The following papers were contributed to this symposium :

H. L. Ahlgren, G. Bohstedt and O. S. Aamodt. Problems in evaluating pastures in relation to other crops.

E. S. Hopkins and P. O. Ripley. Comparative cost of total digestible nutrients in pasture and other crops.

N. J. Thomas. Seasonal variations in chemical composition of pasture, hay and grain from different regions in Ontario.

T. E. Woodward. Relative values of alfalfa hay and a mixture of concentrates for milking cows.

F. B. Morrison. Methods of evaluating live stock feeds.

P. E. Howe. Remarks on evaluation of herbage and pasture.

E. W. Crampton. Some problems in the determination of the nutritive value of pasture herbage.

" The meeting of the American Society of Agronomy, with an attendance of 125, was in the form of a conference relative to the evaluation of comparative nutritive value of pasture herbage, hay and other live-stock feed crops. Papers presented by O. S. Aamodt, P. E. Howe and T. E. Woodward all brought out the limitations of present standards of comparative evaluation, both on the basis of total digestible nutrients and calorimetric measurements. F. B. Morrison, in a paper based on his classical studies along this line, presented the concept of *net energy values*. N. J.

Thomas discussed the great variations in fattening quality of pasture herbage, irrespective of the quantity of feed produced. He suggested that the lignin content may be much more important than the conventional " crude fiber " expression. E. W. Crampton showed that small ' pilot ' feeding trials with rabbits may be used to facilitate research in determining the nutritive value of pasture herbage."

Another paper presented to the section on Agriculture (O) was entitled " Drying of forage crops," in which an account was given of the development of a bin-type drier for hybrid seed corn, and its adaptability to tray-drying of grass crops. (See also special entry for Ecological Society of America.)

Ecological Society of America

The summer meetings of the Society in conjunction with the A.A.A.S. and its divisions were held in Ottawa from June 27 to July 2, 1938, and in San Diego, Cal. (Western Section), from June 20 to 25, 1938. The general Chairman for the Ottawa meeting was Dr. H. C. Hanson, President, and for the San Diego meeting, H. de Forest.

The following are among the papers presented at San Diego :

E. H. Reid, L. A. Isaac and G. D. Pickford. Plant succession on a cutover, burned, and grazed Douglas fir area.

M. W. Talbot. Fluctuations in annual vegetation of the San Joaquin Valley, California.

A. W. Sampson. The relation of chemical characteristics of native vegetation to plant succession.

C. J. Kraebel and C. H. Gleason. Sowing mustard for erosion control in burned watersheds.

W. G. McGinnies. The ecological basis of land management.

H. W. Clark. The association concept and its bearing on geological theory.

A. G. Vestal. Problems of the garrigue-like bush of California.

F. Shreve. Life forms of the Sonoran desert.

The meeting at Ottawa was concerned with animal and forest ecology and also included a paper entitled " Recent work in ecology in the U.S.S.R.," by J. R. Carpenter, of Oxford University, England.

American Society of Plant Physiologists

The Eighth Summer Meeting of the American Society of Plant Physiologists was held in Ottawa, Canada, on June 28 to 30, 1938 in affiliation with the American Association for the Advancement of Science, under the presidency of Dr. O. F. Curtis. Joint sessions were held with the American Phytopathological Society, and the Genetics Society of America. Three extracts from the programme are appended below.

Symposium with the American Phytopathological Society

Micro-elements and deficiency diseases

The general problem of deficiency diseases. W. M. Davis

Spectrographic methods. J. S. Foster

Some relations of micro-elements to animal life. E. J. Underwood

Boron deficiency symptoms in agricultural plants in British Columbia. H. R. McLarty
Boron deficiency symptoms in horticultural plants. W. Ferguson
Cytology of deficiency diseases with special reference to boron. J. Coulson
Thallium toxicity. E. L. Spencer

Symposium with the Genetics Society of America

Drought relations

Xerophytic plants, their evolutionary origin from mesophytes and their possible utilization in culture or as plant breeding material. Walter T. Swingle
Studies on the physiology of drought resistance in cereals. A. G. O. Whiteside
Similarities between drought and frost resistance. J. Levitt
Water absorption as a factor in drought injury. Paul J. Kramer
Water economy of trees in relation to drought. R. D. Gibbs
Some of the investigations on drought relations supported by the National Research Council of Canada. R. Newton
The problem of breeding wheat for resistance to drought. K. W. Neatby
Triticum-Agropyron hybrids for drought areas. F. H. Peto and L. V. P. Johnson
Comparative development of drought resistant wheat varieties under varying moisture supply. J. W. Hopkins

General Programme

An assay method for growth promoting substances utilizing straight growth of *Avena* coleoptile. R. L. Weintraub
Some accessories facilitating adjustment and control of solution flow in Wick-culture method. M. A. Raines
Progress in practical applications of plant hormones. N. H. Grace
The limiting concentrations of sulphur dioxide in relation to plant development. Morris Katz
Growing wheat plants under controlled conditions. R. Newton and W. R. Jack

British Association for the Advancement of Science

The annual meeting of this Association was held in Cambridge on August 17 to 24, 1938, under the presidency of the Rt. Hon. Lord Rayleigh, D.Sc., LL.D., F.R.S.; Professor W. Stiles, F.R.S., University of Birmingham, was President of Section K (Botany), and Professor R. G. Stapledon, C.B.E., President of Section M (Agriculture).

In his presidential address to Section K (Botany) on August 18, Professor W. Stiles (University of Birmingham) reviewed our present knowledge of "The general physiology of the plant cell and its importance for pure and applied botany," dealing only with those physiological functions which are manifested by every living plant cell, namely, respiration, absorption (accumulation) and secretion of water and other dissolved substances. It was emphasized that in the light of recent investigations the orthodox conception that respiration provides the energy for anabolism and plant movements is far from complete, as in some instances respiration was shown to be a continuous vital process maintained even when no plant movement or elaboration of fresh building material could be detected. There is evidence to show that anabolism concerns only the re-formation of carbohydrates, while it

still remains obscure how the energy released in respiration is transformed to produce the anabolites of a higher order.

The absorption of water and other substances has also proved to be a more complex process than a simple diffusion through the cell membranes ; this particularly concerns the absorption of electrolytes, as the ions of salts were shown in some instances to enter the cell against their own concentration gradients. No exhaustive theory has been put forward to account for this and other complexities observed.

There is further strong evidence of the linkage between respiration and salt diffusion into plant cells, which rather suggests that the energy required for the entrance of the salt is provided by respiration and thus the absorption of ions may justly be regarded as a continuous interchange of the former with the hydrogen and carbon ions produced in respiration. The connexion between respiration and accumulation is generally more directly manifested. The accumulation of salts is also a vital process dependent upon the protoplasm, while the absorption of water was shown in some cases to be associated with secretion of water.

In emphasizing the fundamental importance of a closer knowledge of the physiology of a plant cell, both in science and practice, the President stressed the necessity for further study of the protoplasmic mechanism which alone can lead to a better understanding of the general physiology of a plant cell.

The Session the following day, August 19, was devoted chiefly to cell physiology. F. J. Lewis reported some results on " The physical nature of the outer surface of the cell walls of the mesophyll of the leaf." The cell walls proved to be unwettable by water, which does not fill the interspaces, whereas the cell walls are wettable by hydrocarbon solutions. A striking difference in this respect was detected as between the acid and basic chromophore. The former filled up the interspaces, whereas the latter was absorbed on the surface of the walls at the point of entry, while water alone passed on and filled up the interspaces. Fatty acids made the outer surface of the cell wall wettable by water, but they were potent only within certain pH limits.

W. R. G. Atkins drew attention to the utmost importance of a thorough study of " The measurement of light in relation to plant growth and distribution," so as to account for the relation between current and intensity. The optical properties of diffusing surfaces and colour filters, as well as the angular distribution of light, must also be considered.

T. Bennet-Clark and Miss D. Bexon described the experiments (still in progress) on " The roles of osmotic and electrosmotic pressures in the regulation of cell turgor," maintaining that the osmotic pressure gradient cannot account for all the turgor reactions. When protoplasts plasmolysed in potassium chloride of twenty-eight atmospheres were transferred to sucrose of twenty-eight atmospheres or more, the water made a rapid entry from the stronger external to the weaker internal solution, and then passed out of the cells again in a normal direction. In general, in addition to the ordinary osmotic flow, there was observed at pressures of over fifty atmospheres

another water movement under certain circumstances. When tissues were transferred from electrolyte solutions to the non-electrolyte or vice versa there was a flow of water into or out of vacuoles, which was not due to, or was even contrary to the osmotic pressure gradient. A study of the lyotropic series Na—K—Ca—La suggested that these water movements are due to electrostatic factors generated by electrolyte ions. As this " electrosmotic " pressure of over fifty atmospheres could be observed in the cells in which the osmotic pressure was about fifteen atmospheres, it was concluded that these electrosmotic pressures may be largely responsible for many turgor reactions of plant tissues.

T. G. Mason and E. Phillis reported their " Observations on the effects of pressure on the properties of protoplasm " of cotton leaves. Under a hydraulic pressure of 14,000 lb. per square inch a clear sap was expressed from, it is believed, the vacuole through fissures in the protoplasm ; but only about one-third of the total water of the leaf could be expressed in that way ; the rest of the water could be extracted by gently rubbing the residue between the fingers and the thumb. The protoplasm must thus contain a gross structure which can withstand large direct pressures, but which is destroyed by small shearing forces. The residue from the hydraulic press showed normal respiration and water absorption. The tenacity with which the protoplasm retained the water under direct pressure suggests that the continuous medium of protoplasm cannot be aqueous.

Winifred E. Brenchley in her review of the study on " The comparative toxicity of inorganic plant poisons," showed that the poisonous action on growth of higher plants varied with the quantities, with the compound in which it is administered, and with the species of plant. The morphological response to poisons depended upon the element concerned, the growth of roots and shoots being variously affected.

J. Barker summarized his study of " Temperature and the starch/sugar balance in potatoes," concluding that the changes in the Müller-Thurgau relation between hydrolysis of starch to sugar, condensation of sugar to starch, and consumption of sugar in respiration cannot be interpreted solely in terms of the difference in the temperature coefficient of these three reactions. Evidence was quoted to show that sugar accumulation at low temperature is associated with metabolic changes, which persist for a time in spite of a rise in temperature, and that sugar content depends not merely upon the surrounding temperature, but also largely upon the previous temperature history.

R. S. de Ropp and F. G. Gregory, in a report entitled " The hormone system of the rye grain," gave a brief account on the physiological role of the elements of a cereal grain. Growing an excised embryo in distilled water showed the embryo of a ripe grain as a complete mechanism independent in its functions from other parts of the grain. The endosperm provides the growing embryo with, apart from fresh building material, a substance, presumably of a hormonal nature, which activates the growth of roots and coleoptile and their geo- and photo-tropism. The aleurone layer and endosperm form with the embryo an interacting system, the destruction of which after the grain has been soaked leads to marked anomalies in the growth

of the embryo. The aleurone layer seems to be the source from which the scutellum receives a substance activating the elaboration of diastase. The growth of the embryo was affected only when the connexion between the aleurone layer and the endosperm was disturbed before the grain was soaked.

E. K. Woodford and F. G. Gregory, reporting on " The relation of oxygen supply and respiration rate of anion and cation absorption by barley plants at varying nutrient levels," presented in brief a series of short-duration experiments especially designed in order that the interaction of the factors being studied could be analysed statistically and graphically in three dimensions. A considerable absorption under completely anaerobic conditions was claimed for N, P and K. Nutrient concentration was the chief factor in absorption, irrespective of oxygen concentration. The relation between absorption and nutrient concentration was found to be different for anions and cations, while specific effects of ions were also observed in relation to oxygen tension. Respiration was scarcely affected by nutrient concentration and rose with increasing oxygen tension which, while scarcely affecting absorption at low nutrient concentration, had a pronounced effect at high concentrations. In excised roots the rapid fall in absorption preceded the fall in respiration.

G. J. Boswell and G. C. Whiting reported on " The catechol oxidase system," showing that this system had under control more than half the total oxygen uptake and carbon dioxide output in thin slices of potato tubers. The residual respiration was at a maximum in tubers collected and tested in the autumn, but was at a minimum when tested in the following spring after being stored throughout the winter.

On August 23, concurrently with the discussion on plant virus research, Miss E. R. Saunders emphasized " The neglect of anatomical evidence in the current solutions of problems in systematic botany," and pointed out, with reference to her studies of floral anatomy, that a mere description of visible variations is not adequate, but should be supplemented by anatomical information as to how these variations have been brought about. Among others paper read at this Session was that by Mrs. E. R. Sansome and F. W. Sansome on " Genetical experiments with garden peas."

The presidential address to Section M is reproduced on pp. 129-145 of this issue of *Herbage Reviews*. This was followed by Dr. W. G. Ogg on " Problems of marginal and waste land," Dr. E. M. Crowther on " The maintenance of soil fertility," while in a separate session on August 22 a discussion was held on " The practical problems of crop production," to which were contributed papers by J. A. McMillan on " Crop husbandry," Professor F. L. Engledow on " The place of plant physiology and of plant breeding in the advancement of British agriculture," and C. T. Gimingham on " Crop pests and diseases." The general discussion was opened by Sir John Russell.—M.A.O.

New Zealand Grassland Association

The Seventh Conference of the above Association will be held at the Ruakura Farm of Instruction, Hamilton, on October 5 to 7, 1938, under the presidency of A. H. Cockayne. The following contributions are included in the Conference Programme :—

E. B. GLANVILLE. Establishment and management of pastures on gum land carrying scrub.
C. S. DALGLEISH. Establishment and management of pastures on pumice land carrying scrub.
H. E. ANNETT. Waikato pastures.
J. E. BELL. Pastures for wet land.
R. P. CONNELL. Some features of current land utilization.
P. W. SMALLFIELD. Review of topdressing in the Auckland Province.
A. S. JORDAN and S. SMITH. Rehabilitation of deteriorated farms.
E. BRUCE LEVY. Impressions regarding grasslands overseas.
P. S. SYME. Technique of topdressing experiments.
N. H. TAYLOR. Some aspects of erosion of farm lands.
F. HAYWARD. Waikato dairy farm management.
R. B. TENNANT. Demonstration of modern methods in advisory work.
W. RIDDET. Relation of pasture species to quantity and quality of milk.
J. W. WOODCOCK. Harrowing of pastures.
A symposium on relation of health of live stock to pastures will include
J. F. FILMER. Aspects of facial eczema and of the use of cobalt.
Sir T. RIGG. Relationship between the composition of soils and of plants.

Abstracts of those papers which come within the terms of reference of the Herbage Bureau will be included in *Herbage Abstracts* after the Report of the meeting has been received.

First South American Botanical Congress

On the initiative of Dr. P. Campos Porto, Director of the Institute of Plant Biology, Itatiaya, Brazil, of Professor A. Castellanos, Natural History Museum, Buenos Aires, and of Professor F. Rosa Mato, of Montevideo, a Congress of South American botanists has been organized. (*Rodriguesia*. 3. 297-8. 1937.) The Congress is under the patronage of the President of the Republic of Brazil, Dr. Getulio Vargas, and of the Brazilian Minister of Agriculture, Dr. Fernando Costa. It will be entitled the South American Botanical Congress (Reunião Sul Americana de Botanica), and will be held at Rio de Janeiro from October 12 to 19, 1938, under the Presidency of Dr. Campos Porto, its principal aims being the establishment of effective collaboration between the botanists of South America, the consideration of means of protecting the flora of that Continent through the creation of national parks, forest reserves, etc., and the organization of a systematic catalogue of the South American flora. Nine sections will study various aspects of botanical research, including physiology, genetics, ecology and applied botany, and excursions will be made to regions of botanical interest in the vicinity of Rio de Janeiro. Vice-Presidents : Dr. Adolpho

Ducke, Prof. A. J. Sampaio, and Prof. H. Noronha. General Secretary: Prof. F. R. Silveira. Secretaries: Messrs. A. de C. Fernandes, L. de A. Penna, and M. J. B. Magalhães. Enquiries should be addressed to: The Organizing Committee of the 1st R.S.A.B., Jardim Botanico, Rio de Janeiro, Brazil.—G.M.R.

Seventh International Botanical Congress

The Seventh International Botanical Congress will be held in Stockholm, Sweden, on July 17 to 25, 1940. The Congress will be divided into eleven sections.

AGR AGRONOMY (Recorder: Prof. H. OSVALD, Lantbrukshögskolan, Uppsala)
CYT CYTOLOGY (Recorder: Dr. O. HEILBORN, Germaniavägen, 6, Djursholm)
EXE EXPERIMENTAL ECOLOGY (Recorder: Prof. G. TURESSON, Lantbrukshögskolan, Uppsala)
GEN GENETICS (Recorder: Prof. A. MÜNTZING, Svalöv)
MOR MORPHOLOGY and ANATOMY (Recorder: Prof. H. KYLIN, Botaniska Institutionen, Lund)
MYC MYCOLOGY and BACTERIOLOGY (Recorder: Prof. E. MELIN, Botaniska Institutionen, Uppsala)
PB PALAEOBOTANY (Recorder: Prof. T. G. HALLE, Riksmuseum, Stockholm 50)
PHG PHYTOGEOGRAPHY (including Comparative Ecology) (Recorder: Prof. G. E. DU RIETZ, Växtbiologiska Institutionen, Uppsala)
PHP PHYTOPATHOLOGY (Recorder: Prof. T. LAGERBERG, Skogshögskolan, Experimentalfältet)
PHYS PLANT PHYSIOLOGY (Recorder: Prof. H. LUNDEGÅRDH, Lantbrukshögskolan, Uppsala)
SYST TAXONOMY and NOMENCLATURE (Recorder: Dr. J. A. NANNFELDT, Botaniska Institutionen, Uppsala)

The Congress will visit the botanical institutions of the University and the Swedish College of Agriculture at Uppsala in addition to several botanical institutions in and near Stockholm. Visits will also be paid to Lund (Botanical Institute) and Göteborg (Gothenburg Botanical Garden).

The following excursions are also proposed:

Phytogeographical excursion (2 weeks) to South Sweden, before the Congress;

Excursion to Lund, Svalöv and Landskrona in South Sweden (1-3 days), before the Congress, for the purpose of visiting certain plant-breeding stations;

Phytogeographical and floristic excursion into the Stockholm Archipelago (1 day), during the Congress week;

Mycological excursion to Femsjö in Småland (1 week), the collecting ground of Elias Fries, after the Congress;

Phytogeographical excursion (3-4 weeks) through North Sweden, after the Congress; and

Floristic exursion (1 week) to Abisko in North Lapland, after the Congress.

More detailed information may be obtained from the Secretary, Dr. C. R. Florin, Riksmuseum, Stockholm 50, Sweden. Further notices about the Congress will be distributed early in 1939.

ANNOTATIONS

GERMANY (43)

Biological Institute, Berlin-Dahlem

A brief review of the activities of the Institute (Biologische Reichsanstalt für Land- und Forstwirtschaft, Berlin-Dahlem) is presented by its Director, Dr. E. Riehm, in *NachrBl. dtsch. PflSchDienst.* 18. 49-51. 1938. Work has included geographical studies of *Lupinus*, *Medicago* and *Ornithopus*, the study of nodule bacteria in legumes with special reference to specific differences, experiments in the use of refuse for improving poor land and in the use of various kinds of sludge in establishing grass landing-grounds for aeroplanes. Within the last five years the staff of the Institute has been considerably augmented, and the number of branch stations has been increased from eight to ten.

Agricultural Institutes of the University of Halle

A short retrospect of the work of the six Institutes is given in pp. 1-46 of *Kühn-Archiv*, Vol. 50. 1938. This volume is a special number published to celebrate the seventy-fifth anniversary of the Institutes' existence. Various aspects of herbage and forage crop production are studied by the Plant Breeding Institute, the Dairy Institute, the Live Stock Institute, and the Institute for Plant Nutrition and Soil Science.

Association for the Improvement of Grassland in the Lower Oder Basin

A report on the work of the Association for 1936, the fourth year of its existence, was published in 1937 (Koenekamp, A., and Siegert, R. Tätigkeitsbericht 1936 der Arbeitsgemeinschaft zur Verbesserung der Wiesen an der unteren Oder. Landsberg (Warthe). 1937. pp. 46.) Tables showing rainfall and the average level of the river Oder in the different months preface the report, which describes the progress of experiments conducted near Fiddichow, Greifenhagen, Gartz and other localities. They are concerned with the following subjects. (a) Experiments (two remaining out of the original five) in the improvement of neglected meadows by means of manurial treatment, with special reference to the effect of nutrient deficiency upon hay and protein yield and upon botanical composition. In discussing results it is noted that manurial treatment alone offers little prospect of satisfactory improvement. (b) Two grass variety trials, in progress since 1933, to test the suitability of different species and varieties grown alone and in mixtures, for use

under different conditions in the lower Oder basin. The tabularized results show that the plots, sown down in 1933 and 1934 respectively, have maintained on the whole an unusually high standard of performance, wherein the mixtures in particular tend to improve in yield with the years. The steady improvement in the yield of *Trifolium hybridum* and *T. repens* is attributed to the regulation of the soil moisture. (c) Four trials of mixtures and management for temporary clover-grass leys. (d) Pasture trial. This included variously treated paddocks on land normally flooded in winter, in 1936 until April 1. From the end of April to the middle of May the subsoil water rose to the surface ; grazing could not be begun until May 28, and the water table remained high throughout the grazing period. Data are presented on botanical composition under the various treatments ; hay yield after grazing ; number of pasture days, yield of green grass, and grass growth per day (for the four years, the amount of herbage being seen to increase year by year), live weight increase, etc. Scarifying and reseeding have been found to result in improvement, and general results are considered good. (e) Regulation of soil water. A polder normally flooded in winter and until late in spring, and having a very high water table during the growth period, has been used for pumping and water movement experiments. The beneficial effect upon the soil, upon the botanical composition of meadow sward and upon the yield of hay and other crops is demonstrated. (f) Two experiments, laid down in 1933 on heavy alluvial clay, water table ranging from 12 to 45 cm. below the surface, the original sward (1932) composed mainly of *Carex* and *Ranunculus*. The results (hay and protein yield and botanical composition) of the various treatments (different manurial treatment, two different methods of scarifying and two different seeds mixtures) in the respective years are tabulated and discussed. Reseeding produced a great suppression of weeds. (g) Model plots of hay mixtures suitable for use under the peculiar conditions (frequent flooding and high water table) of the Oder basin.—G.M.R.

HUNGARY (439.1)

In *Kisérl. Kozl.* 40. 29-44. 1938, S. A. Tunyogi presents a report on the International Lucerne Test inaugurated in 1932 by the Imperial Bureau of Pastures and Forage Crops, Aberystwyth, as carried out at the Royal Hungarian Plant Breeding Station, Szeged. The following are the principal observations made at Szeged.

On an average for the four years, Provence and the Hungarian standard varieties gave the best results in regard to growth vigour, while Khivian and Grimm took a lower position.

Habit : Grimm and Khivian creeping, Turkmen and Middle Turkestan erect.

Percentage winter killing : in the first winter Provence suffered most, the Hungarian and Russian varieties least.

A table presents data on flowering.

Green weight : best yield was obtained from the Hungarian Standard, from

Middle Turkestan and Nagyszénás. Grimm came last of all, and on the whole the varieties came in the same order in regard to hay yield, but according to the author the data on hay yield are very variable.

In most cases the first cut gave almost half of the year's yield. Contrary behaviour was, however, exhibited by Turkmen and Provence, in which the first cut gave a relatively poor yield.

Percentage leaf : in general this was approximately 30 per cent in the first cut, and up to 70 per cent and more in the last cuts. The highest percentage of leaf was found in Grimm, the lowest in Semiryechensk.

Leaf measurements : the varieties were populations and therefore varied considerably in this respect ; the smallest leaf surface was found in Grimm.

Development rhythm : the Hungarian varieties flower earliest, Semiryechensk latest.

Seed ripening : Hungarian was the earliest variety, then came Grimm. Provence was medium early. Of the Asiatic varieties Asia Minor was the earliest to flower, and the latest in regard to seed ripening.

Seed yield : less in the early varieties than in the late. First shoots gave better results than the subsequent ones. In the third year Semiryechensk had the greatest mean seed yield, Provence the lowest.

Flower colour : this was observed by means of the Ostwald-Krüger colour chart. The main colour was violet-blue, in the case of Turkestan there were many black-violet flowers.

Pod form and spiral : there was a lower number of spirals in the second and later seed cuts. The harvesting of seed from the first cut unfortunately presents technical difficulties in Hungary.

The smallest number of spirals per pod were found in the Asia Minor variety ; according to the author this is probably due in the main to *falcata* characters.

Biometrical measurements of the stem were carried out for all the varieties. Khivian had a large number of shoots. The longest stems were found in Semiryechensk, Middle Turkestan and Asia Minor, the shortest in Grimm and Provence.

Hairs : the stems were most hairy in some Hungarian varieties, least in Khivian, the leaf was most hairy in some Hungarian varieties and in Grimm, least in Turkmen.

From frost at the beginning of May, 1935 (min. –7°C.) Provence suffered most and Grimm least.—R.F.

FINLAND (471.1)

Siemenjulkaisu

This publication, the English equivalent of which is Seed Report, is published by the Hankkija and contains, among other things, a report on the work of the Tammisto Plant Breeding Station, Malmi, Finland. It is hoped to produce a complete review of this work in *Herbage Reviews*, Vol. 6. No. 4. 1938.

ESTHONIA (474.2)

Moor Experiment Station, Tooma

A short report on the work of the Esthonian Moorland Association, Tartu, where the laboratories are situated, and of its Moor Experiment Station at Tooma for the year 1937-38 is published in *Sookultuur*, Vol. 17, 1938, by the Director of the Station, L. Rinne. The work of the Society and the Station is experimental, advisory and educational. A survey of its achievements during the first twenty-five years of its existence was published in English in 1934 (Rinne, L. The Esthonian Moor Society and the Experimental Station of Moor-Cultivation at Tooma. A short survey in celebration of the twenty-fifth anniversary of the Esthonian Moor Society. Univ. Tartu, 1934. pp. 31).

In addition to the ordinary meetings of the Society, a special meeting was held at Tooma in 1937, and the present position of moorland cultivation in the country was outlined, findings being based on the information obtained through sending a questionnaire to 199 moorland farmers. These findings are briefly summarized in the report and demonstrate the economic value of reclaiming uncultivated moor.

Experiment and research at the Station in 1937-38 have been principally concerned with the manurial treatment of grassland.—G.M.R.

NORWAY (481)

Agricultural College of Norway

Under section 4 of the Annual Report of the Agricultural College of Norway for the year ending June 30, 1936, *Practical work* is discussed.

Of the total area of 174 dekar sown with root crops, 35 dekar carried fodder beet. The dry matter content, although not particularly good this year, was slightly better than in 1934. In fodder beet it was 10.87 per cent, in turnips 9.56 per cent.

Cutting of meadows was begun on July 1 and completed on July 11. Some of the meadows were cut for experimentation on June 28 and July 19.

The yield of hay was very low, from 318 to 484 kg. per dekar, on the average 430 kg. This was the lowest yield obtained since 1923, when it was only 368 kg. per dekar.

The pastures received an application of 12.0 kg. nitro-chalk, 20 kg. superphosphate and 8 kg. 40 per cent potash per dekar. The yield was considerably less than that of the previous year, owing to drought. In August and September it was found necessary to supplement pasture by concentrated fodder, on the average 1 kg. per animal per day.—R.P.J.

Norwegian State Seed Testing Station

Work undertaken at the above Station during the period July 1, 1936 to June 30, 1937, included the following :

Field control. In the new rules for state-aided production of stock seed (printed in the autumn of 1936) it was decided that all stock seed of agricultural crops shall be investigated by the Norwegian Seed Control Department, as to genuineness of strain, purity of strain and freedom from seed-borne plant diseases.

Besides stock seed the Felleskjøp (Co-operative Society) in Oslo sent in 7 samples of Norwegian-grown seed of roots, 3 samples of swedes and 4 of turnips for control cultivation. One sample of swedes contained 5.3 per cent deviating types. In accordance with the new import regulations, imported seed of turnips and swedes will be grown under control in the exporting country concerned.—R.P.J.

SWEDEN (485)

Dr. Nils Sylvén, formerly in charge of the department for herbage plants at Svalöf Plant Breeding Institute, has now been appointed head of the new Institute of Forest Tree Breeding.

NETHERLANDS (492)

State Agricultural Station, Groningen

The Station's Report for 1937 (Verslag van het Rijkslandbouwproefstation voor den Akker- en Weidebouw te Groningen over 1937. 's-Gravenhage, 1938. pp. 32) is divided into four parts, the first of which deals with soil studies, and the second with manurial and plant nutrition studies. Of these, experiments relating to grassland and forage crops include studies of the effect of nitrogen in relation to the time of mowing ; the effect of phosphatic fertilizers in conjunction with the foregoing ; the effect of phosphatic fertilizers upon botanical composition, with special reference to clover ; comparison of superphosphate and basic slag in the reclamation of heath ; the effect of drainage upon old grassland ; "soil sickness."

The third section of the report relates to work on the technique of cultivation and allied problems. The following are among the matters which have been studied. The effect of the removal of water from an area upon the botanical composition of the sward. Improvement of the sward covering of a sea dike. Botanical analysis in the field. Grazing technique and pasture management, in conjunction with the quality of the milk produced. Root growth and the conditions affecting it. Vernalization experiments with tomatoes, rape, etc. Inoculation and the supply of inoculants. Soybean trials and further study of lucerne growing. The question of whether

there is any connexion between the composition of grass or hay (as affected by manurial treatment, the time at which it is cut, etc.) and foot and mouth disease is under investigation.

In the fourth section of the report, which is concerned with work on the composition, quality and treatment of crops, reference is made to the large number of analyses—chemical and botanical—of herbage samples made at the Station, and to studies preparatory to the artificial drying of grass (data collected in Great Britain during the Fourth International Grassland Congress).

A list of publications by members of the Station's staff is appended.—G.M.R.

The N.A.K. (Netherlands General Inspection Service)

The fifth annual report covers the year 1936-37 (Vijfde Jaarsverslag van de Nederlandsche Algemeene Keuringsdienst (N.A.K.) over het boekjaar 1936-37. Wageningen, 1937. pp. 104. French summary). Committees appointed to study special subjects include one on the breeding of clover and the clover seed trade. A Grass Seed Association, under the direction of the Director of the Plant Breeding Institute, Wageningen, has been formed. It consists almost entirely of firms engaged in the breeding of grass seed. For the present the Association itself is to be responsible for the inspection of its own strains, an assistant from the Plant Breeding Institute being in charge of this work. A resolution of the Committee on Technique notes that, in inspecting grass seed for weed content, the inspection of samples is of more importance than field inspection, since modern cleaning plant can satisfactorily eliminate weed seeds, but overgrown fields should nevertheless be disqualified. Figures for the grass and clover seed crops inspected in 1936 are given on p. 77.—G.M.R.

RUMANIA (498)

Agricultural Research Institute

A report on the organization and work of the Agricultural Research Institute of Rumania from its foundation in 1927 up to 1936 has been published by Dr. G. Ionescu-Şişeşti, the Director. (Ionescu-Şişeşti, G. L'organization et l'activité de l'Institut de Recherches Agronomiques de Roumanie de 1928 à 1936. Bucarest, 1937, pp. 36. pls.) The Institute itself, situated at Bucharest, comprises eight Sections and three Stations. The Section for Phytotechnology includes in its work the study of soybean varieties and of cultural methods, including dry farming, and special attention is paid to research on herbage and forage plants. In the Seed Control Section apparatus for ridding seed of *Cuscuta* was installed in 1934, since when 769,372 kg. clover and lucerne seed have been cleaned. Large quantities of seed of herbage and forage plants have been certified and sealed. The Plant Breeding Section, with which the

seed control Section is incorporated, has produced two valuable strains of Dent maize and is engaged on the improvement of the sunflower, among other plants.

In addition twelve agricultural experiment stations in various parts of the country form part of the Institute. At seven of them seed production is carried out, at two seed control is exercised. The following is some of the work done at different stations.

Baragan : This Station, founded in 1930, is chiefly concerned with the study of varieties and cultural methods suitable for the steppe region in which it is situated. Maize and soybeans are among the plants of importance, and a valuable maize strain named Heterosis has been obtained by crossing two varieties.

Valul lui Traian (founded 1933) : Study of questions concerning the Dobruja steppe. The dry farming system is considered better for this region than the habitual methods, and forage crop trials have indicated the following to be the most suitable for the region : *Onobrychis sativa*, *Sorghum saccharatum*, *Sorghum exiguum* and forage maize.

Jassy (founded 1930) : Large quantities of seed of clover, lucerne and of *Phleum pratense* have been certified. Variety trials have been conducted, and a study of the many varieties and races of cultivated plants existing in the neighbourhood. The breeding of maize, among other plants, is carried out.

Targu Frumos (founded 1931) : Study of questions concerning Moldavia and Bessarabia ; breeding of maize and sunflowers, variety trials of forage and herbage plants. An orange maize variety selected at the Station gives the best results in the region.

Cluj : Three agricultural research stations, founded at different dates from 1884 onwards, were combined in 1931 under the title of the Plant Breeding and Seed Control Station. In addition to cereals and other crops, clover and herbage grasses are bred and valuable strains have been obtained. Phytopathological studies of the breeding material are also made. Large quantities of clover and lucerne seed have been analysed, certified and sealed.

Câmpia Turdei (founded 1931) : Study of questions concerning central Transylvania. Breeding work is carried out in collaboration with the Cluj Station, the objects of research including maize and lucerne. Variety trials have demonstrated the superiority of the following varieties for the region in question : for quality, the orange maize ; for yield, Fleischmann's maize ; for earliness, the yellow Câmpia Turdei variety. Studies of cultural methods concern the following, among other plants : maize, fodder beet, herbage grasses and legumes, the soybean.

Cenad (founded in 1922 by a Limited Company and now taken over by the State) : A large amount of pedigree seed is produced and distributed. It includes the productive and drought-resistant maize " Regele Ferdinand," and the fodder beet " Sacharosa." Variety trials of the soybean and experiments in methods of cultivating this crop are in progress.

Moara Domnească : Work is done in collaboration with the National Agricultural Society. Varietal trials and experiments in methods of cultivating maize and soybean are conducted. In the case of maize the practices of light scaling in summer, deep tillage in autumn and the use of the cultivator in spring are found to produce the best results.

The Institute publishes Annals (Analele Institutului de Cercetări Agronomice al Romaniei) containing original work, of which nine volumes have now appeared ; and in addition a series of monographs and a series of popular writings.—G.M.R.

SOUTH AFRICA (68)

University of Pretoria Grassland Research Committee

Each year the Grassland Research Committee of the Faculty of Agriculture issues a Progress Report (mimeographed) on soil erosion and grassland experiments which are carried on at Pretoria. Most of the work embodied in this report has been made possible as a result of a grant given by the South African Department of Agriculture. The Committee also express their appreciation to Messrs. African Explosives and Industries, Ltd., for generous assistance. The Committee has the following personnel :—Prof. R. Lindsay Robb (Chairman) ; Prof. A. M. Bosman ; Mr. F. N. Bonsma ; Mr. E. S. Dawson ; Dr. G. D. Haylett ; Prof. J. M. Hector ; Prof. H. D. Leppan ; Prof. J. C. Ross ; Miss N. S. Schoeman (Clerk to the Committee).

The following is a complete list of the experiments of which data regarding object, experimental lay-out and progress results are given for 1937.

P.I. No.
17 Soil moisture and erosion studies
22 Fertilizing of natural veld grazed rotationally by sheep
55 Veld survey
64 Management and utilization of Rhodes grass (*Chloris gayana*), woolly finger (*Digitaria*) and natural veld pastures
68 Fertilizing and cultivation of natural veld
135 Influence of seasonal overgrazing on veld
136 Critical growth period of veld species
137 Influence of type and intensity of defoliation on a veld sward
138 Influence of time and duration of rest period on a veld sward
139 Utilization of woolly finger as sheep pasture
143 Influence of time and duration of rest period on a veld sward (Frankenwald)
154 Fertilization of Rhodes grass
155 Influence of seasonal overgrazing on Rhodes grass
156 Influence of type and intensity of defoliation on Rhodes grass
158 Intermittent and continuous grazing on veld by sheep
159 Beef production from Rhodes grass
187 Effect of cultivation on Rhodes grass
188 Intensity of grazing of woolly finger
189 Effect of grazing and resting on winter growth and quality of woolly finger
190 Fertilizing of woolly finger
191 A study of the water relations of *Themeda triandra* (Forsk.)

202 Veld management
203 Varying methods of defoliation of Rhodes grass
204 Effect of cultivation on a veld sward
205 Management of Rhodes grass
206 Effect of seasonal mowing on a veld sward.

The following scheme of experiments is being carried out at the Morale Pasture Research Station, Mahalapye, Bechuanaland Protectorate, in co-operation with the University of Pretoria. This Protectorate differs materially in climate and vegetation from the Union of South Africa and Southern Rhodesia and consequently experimental results obtained by these territories are rarely applicable under Protectorate conditions. Animal production is the most important industry in the Territory and the need for research into the problems of pasture management was acutely shown during the last severe drought, when the losses due to death of stock brought many farmers to the brink of ruin and vast areas of good natural pasturage were almost denuded of their vegetation. Since no reliable data are available for this region it was considered essential to establish a properly equipped station for the investigation of these problems.

The conditions at Morale are as follows :

Area :	1200 acres
Altitude :	3,000—3,400 feet
Rainfall :	10—18 inches (erratic)
Soil type :	Sandy soil mainly from granite with local patches of calcareous tuft and brackish in isolated hollows or pans. The whole area is exceedingly flat with very little run-off, and consequently losses of soil through erosion are insignificant. For such a large area the degree of uniformity is remarkable.

The bush and grass vegetation of the experimental area is described. The following experiments are in progress at Morale :

M. No.
1 Carrying capacity of veld
2 Alternate summer and winter grazing
3 Carrying capacity of veld with supplementary feeding
4 Carrying capacity of veld under deferred grazing system
5 Time and duration of rest period
6 Seasonal overgrazing
7 Production of hay.

The Nursery Investigational Area comprising 80 acres is being cleared and work on the following lines is contemplated : (1) investigation of the more promising indigenous grass species, (2) investigation of the possibilities of producing supplementary feed, for example, spineless cactus, cattle melons, dryland lucerne, saltbush, etc.—R.O.W.

U.S.A. (73)

Illinois Agricultural Experiment Station

A half-century of achievement by the Illinois Agricultural Experiment Station was described at the fiftieth anniversary of the Station on March 25, 1938, by the late Dr. H. W. Mumford, who died on May 14, An abstract of the address is published as the chief contribution to *Science* Vol. 87, No. 2268, June 17, 1938, together with an abstract of an address by Dr. Eugene Davenport on the early days of the Station.—R.O.W.

URUGUAY (899)

Institute of La Estanzuela

A retrospect of plant research and improvement in Uruguay is presented by Prof. Boerger in *Arch. fitotéc. Uruguay*. 2. 287-391. (English and German summaries, 376-85.) 1937. The work was authorized by the Government in the law of September 30, 1911, and began with the arrival of the author from the University of Bonn in 1912.

In this retrospect the steps leading to the acquisition of the estate and to the establishment of the Institute at La Estanzuela (Instituto Fitotécnico y Semillero Nacional La Estanzuela), the present centre of activities, are outlined, and a description is given of the organization and development of the Institute's work, its present position, and the results already achieved. The Institute has at its disposal 2,795 acres of land, some forty buildings (administrative, laboratories, etc.), a scientific staff of eleven, and a total personnel of 120. Work is described under the following headings: cereals and flax; phytopathology; milling and panification; industrial and forage plants; maize and general biology (including the study of photoperiodism and vernalization); seed department. In the selection of herbage and forage plants progress is reported in the obtaining of a Sudan grass practically free of HCN and in the formation of more productive varieties, in the obtaining of forms of *Bromus unioloides* adapted to Uruguayan conditions, in the adaptation of *Chloris gayana* and *Pennisetum purpureum*, and in the obtaining of an oat (*Avena byzantina* No. 1095a) especially suitable for winter grazing. The soybean, *Lespedeza*, *Lupinus albus*, some *Vicia* spp. and *Adesmia bicolor* are being studied for their value as forage crops for the more intensive types of farms, and much attention is devoted to the genetical and cultural study of *Medicago*. Finally, the work is discussed in relation to the economic evolution of Uruguay, and a bibliography of publications by the staff of the Institute from 1935 to 1937 is appended, complementary to that published in 1935 (see *Herb. Abstr.* 5. 167. 1935).—G.M.R.

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